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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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The Secretary of the Interior has deterimined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1991.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most our our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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04 WATER QUANTITY MANAGEMENT AND CONTROL

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

COMPUTERIZED DATA MANAGEMENT SYSTEM FOR WELLFIELD PROTECTION.
Pirnie (Malcolm), Inc., Columbus, OH.
For primary bibliographic entry see Field 5G.
W91-03939

ABLATION OF AVALANCHED AND UNDISTURBED SNOW, HIMALAYA MOUNTAINS, PAKISTAN.
Okanagan Coll., Kelowna (British Columbia). Dept. of Geography.
For primary bibliographic entry see Field 2C.
W91-04129

RELATIONSHIPS IN REGIONAL GROUNDWATER DISCHARGE TO STREAMS: AN ANALYSIS BY NUMERICAL SIMULATION.
Alberta Univ., Edmonton. Dept. of Geology.
D. Ophori, and J. Toth.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 215-244, November 1990. 17 fig, 1 tab, 28 ref.

Descriptors: *Alberta, *Base flow, *Groundwater movement, *Regional analysis, *Surface-groundwater relations, Discharge-drainage area relationships, Groundwater recharge, Mathematical models, Numerical analysis, Simulation.

Baseflow components of streamflow were determined for 32 selected basins in the Plains Regions of Alberta. Plots of baseflow per unit area versus total basin surface (q(A) curves) show a rapid increase in baseflow rate with initial increase in basin area, followed by a reduced rate of increase at larger basin areas, suggesting a functional dependence of baseflow rate on basin size. Empirically determined baseflow relationships were studied by numerical simulations of groundwater flow in two-dimensional vertical sections. These models show that the baseflow relationships develop according to the theory of regional gravity flow of groundwater. The types of discharge relationships indicate greater baseflow in regional discharge areas (areas of low topography and including local recharge regions) than in regional recharge areas (areas of high topography and including local discharge regions). An asymptotic discharge-drainage area relationship was obtained that showed a high rate of increase of specific discharge with initial increase in basin area from the headwaters downgradient. Several parameters act to modify the shape and nature of the asymptomatic relationship, namely: depth-to-width ratio, regional slope, and geology of the basin. Low depth-to-width ratio and low regional slope convert the asymptotic relationship to a stationary discharge-drainage area relationship that gives a constant specific discharge for the entire range of basin area, and identifies a flow pattern of wholly local systems. Contrarily, high depth-to-width ratio, high regional slope, and the presence of aquifers in a basin transform the asymptotic relationship into a discharge-drainage area relationships that describes a linear increase in specific discharge with basin area. Inverse discharge-drainage area relationships or mirror images of all three above relationships are formed when specific discharge is plotted against basin area, which increases from low elevation upgradient towards the headwaters. The discharge-drainage area relationships uncovered in the study demonstrate quantitatively that sub-basins at low topographic elevations possess more water than those of equivalent sizes at high topography. (Author's abstract)
W91-04400

INFLUENCE OF THE BIOSPHERE ON THE GLOBAL CIRCULATION AND HYDROLOGIC CYCLE--A GCM SIMULATION EXPERIMENT.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W91-04493

WATER RESOURCES OF THE ELK RIVER BASIN, WEST VIRGINIA.
Geological Survey, Morgantown, WV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04642

SURFACE- AND GROUND-WATER INTERACTION AND HYDROLOGIC BUDGET OF THE MISSOURI RIVER VALLEY AQUIFER BETWEEN YANKTON SOUTH DAKOTA, AND ST. LOUIS, MISSOURI.
Geological Survey, Lawrence, KS. Water Resources Div.
E. R. Hedman, and D. G. Jorgensen.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Atlas HA-721, 1990. 1p, 3 fig, 2 tab, 1 map, 9 ref.

Descriptors: *Aquifer systems, *Aquifers, *Groundwater budget, *Groundwater resources, *Hydrologic maps, *Maps, *Mississippi-Missouri River Basin, *Surface-groundwater relations, Geohydrology, Hydrologic budget, Missouri, South Dakota.

The thickness and width of the Missouri River Valley aquifer differ greatly in the study reaches of the Missouri River; thickness of the aquifer ranges from $>$ 50 ft to $<$ 300 ft, and the width ranges from about 4 mi to $>$ 15 mi. Analysis of the elements of the hydrologic budget indicates that the Missouri River Valley aquifer gains water in five of the reaches and loses water in five others. The Missouri River Valley aquifer is in hydraulic connection with three regional geohydrologic units (Great Plains Aquifer system in the upstream reaches, Western Interior Plains confining system in the middle reaches, and Ozark Plateaus aquifer system in the downstream reaches). The gains and losses in flow are related to the regional geohydrology and, therefore, are assumed to be due to interaction between the Missouri River-Missouri River Valley aquifer and the regional geohydrologic units rather than other unevaluated sources or sinks. Gains and losses in the 10 reaches ranged from -908 to +1,219 cu ft/sec; however, the accuracy of the calculated gains and losses can not be fully ascertained. (Lantz-PTT)
W91-04856

STREAMFLOW GENERATION PROCESSES: AN AUSTRAL VIEW.
Forest Research Inst., Christchurch (New Zealand). Forest and Wildland Ecosystems Div.
For primary bibliographic entry see Field 2E.
W91-04931

LINKING HYDROLOGICAL, GEOCHEMICAL, AND SOIL CHEMICAL PROCESSES ON THE CATCHMENT SCALE: AN INTERPLAY BETWEEN MODELING AND FIELD WORK.
Senter for Industriforskning, Oslo (Norway).
N. Christophersen, and C. Neal.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3077-3086, December 1990. 7 fig, 48 ref.

Descriptors: *Field tests, *Geochemistry, *Hydrology, *Interdisciplinary studies, *Mathematical models, *Soil chemistry, *Watersheds, Acid rain, Acid rain effects, Experimental basins, Hydrologic cycle, Research priorities, Soil water.

Quantification of the major processes controlling soil, soil water, and stream water chemistry are hampered by the traditional divisions within the terrestrial sciences. Acid rain research starting in Norway in the late 1970s is characterized by a close connection between modeling and field work. In 1982, the Birkenes model offered an integrated picture of the link between acid deposition and acid freshwaters. Since that time, new field data from Birkenes and other sites have been collected to test and improve the model. The picture now emerging is that stream water can be considered as a mixture of observed soil waters (end-members), with contributions depending on the hydrological conditions. Thus the hydrological question of water flow paths is elucidated using chemical information. Sufficient motivation for interdisciplinary research can be obtained if scientists become more willing to pursue problems and not disciplines. (Author's abstract)
W91-04935

2B. Precipitation

MODELLING SHORT-TIMESCALE VARIATIONS IN RAIN-RATE.
Essex Univ., Colchester (England). Dept. of Mathematics.
D. A. Holland, and G. J. G. Upton.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1549-1554. 4 fig, 3 tab, 7 ref. Rutherford Appleton Laboratory Grant No. N2A 5R 0607.

Descriptors: *Model studies, *Rain gages, *Rainfall distribution, *Rainfall intensity, *Rainfall rate, *Rainstorms, *Simulated rainfall, *Statistical analysis, Convective precipitation, England, Storms.

Data from a rapid response rain gage, situated in Suffolk, England, comprised 104 events, 52 of which contained medium to heavy rain rates. Heavy storms cause the most problems, and the temporal variation of the rain-rate, especially within these important heavy storms, was of particular interest during this study. Substorms were defined within each storm and separated by no more than three dry minutes; within the 52 medium to heavy storms a total of 92 substorms were identified, for a mean of 1.7692 substorms per storm. A statistical model was constructed which was used to produce simulated data corresponding to four hundred years of rainfall. Formulae were developed that permit the calculation of the number of convective storms per year, dropcounts, and exceedance percentages. From the simulated data, estimates were made of the long-term percentage of time over which given rain-rates are exceeded, together with their 95% confidence limits. This data is used to predict the amount of time a communications link can be expected to be out due to falling rain. (See also W91-03944) (Tappert-PTT)
W91-03960

RAINFALL INTERCEPTION IN TWO TROPICAL MONTANE RAIN FORESTS, COLOMBIA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
For primary bibliographic entry see Field 2I.
W91-04101

HOLOCENE HISTORY OF THE EL NINO PHENOMENON AS RECORDED IN FLOOD SEDIMENTS OF NORTHERN COASTAL PERU.
California Univ., Berkeley. Dept. of Geography.
L. E. Wells.
Geology GLGYBA, Vol. 18, No. 11, p 1134-1137, November 1990. 4 fig, 1 tab, 21 ref. National Science Foundation Grant EAR-85-03886.

Descriptors: *Climatology, *El Nino/Southern Oscillation, *Flood frequency, *Flood plain sediments, *Paleohydrology, *Peru, *Stratigraphy, Archaeology, Coastal plains, Flood profiles, Geologic history, History, Radioactive dating, Rainfall-runoff relationships, Sediment analysis.

El Nino is an episodic event that perturbs the ocean-climate system of the Pacific basin and is related to anomalous weather patterns worldwide. The desert climate of the Peruvian coast results in a direct correspondence between terrestrial flooding and the El Nino phenomenon; significant precipitation along the north-central coast of Peru occurs exclusively during El Nino incursions of warm water into the Peruvian littoral. Flood deposits from this region therefore provide a proxy record of extreme El Nino events. A 3500-year chronology was compiled of the extreme events based on radiocarbon dating of overbank flood sediments from the Rio Casma. The flood plain

stratigraphy suggests that the El Nino phenomenon has occurred throughout the Holocene and that flood events much larger than that which occurred during 1982-1983 occur at least once every 1000 years. Two scenarios which would explain the frequency of the largest floods are: (1) 'mega-El Nino events' exist that cause major flood devastation in coastal Peru and perhaps extreme climatic anomalies worldwide, or (2) once every 1000 years the rainfall associated with the El Nino event is distributed such that exceptional flooding occurs near Casma. Archaeological data suggest that the flood events recorded here are large-scale disasters that affected the entire northern coastal zone of Peru and, if repeated, may have global-scale climatic implications. (Fish-PTT)
W91-04109

DEVELOPMENT AND TESTING OF SINGLE-PARAMETER PRECIPITATION DISTRIBUTIONS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
J. S. Selker, and D. A. Haith.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2733-2740, November 1990. 7 fig, 3 tab, 19 ref, append.

Descriptors: *Data interpretation, *Mathematical studies, *Meteorology, *Model studies, *Precipitation intensity, *Rainfall distribution, *Statistical methods, *Statistical models, Precipitation.

Mathematical models of wet day precipitation amounts are useful in a variety of water resource applications. When available, historical records of daily precipitation may be used to estimate parameters of appropriate probability distributions. However, in many cases, these records are either inaccessible or nonexistent, and information is limited to regional summaries of mean monthly precipitation and number of wet days. In such situations, precipitation probability distributions based on a single parameter are required. A general procedure was developed for calibrating multiparameter probability distributions of daily precipitation to single-parameter distributions. The approach used monthly precipitation summaries and data from U.S. Weather Bureau Technical Paper 57. The three-parameter beta-P model of daily precipitation amount was calibrated for 33 sites east of the Rocky Mountains. The resulting single-parameter Weibull distribution and two other single-parameter precipitation distributions were compared with respect to their fit to Paper 57 summaries and historical daily precipitation records. The Weibull model was shown to yield significant improvement over the other models in reproducing precipitation probability distributions. (Mertz-PTT)
W91-04126

HYBRID MODEL FOR FORECASTING DAILY RAINFALL.
Institute of Flood Control and Drainage Research, Dacca (Bangladesh).
S. A. Wasimi.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2741-2746, November 1990. 5 fig, 8 tab, 24 ref.

Descriptors: *Bangladesh, *Forecasting, *Mathematical models, *Meteorology, *Model studies, *Rainfall rate, Atmospheric pressure, Dhaka, Fourier analysis, Humidity, Monsoons, Precipitation, Rainfall, Seasonal variation, Temperature.

In a hydrologic basin where precipitation rates have strong seasonal characteristics, simple seasonal forecasts of rainfall along with regression analysis on a few related meteorolgical observations can be used to obtain an estimate of the anticipated rainfall rate one day in advance. A model for forecasting daily rainfall with one day lead time was developed. The model used smoothed normal daily rainfall rates as seasonal forecasts and a linear regression model on deviations of atmospheric pressure, temperature, and humidity from their seasonal mean values for estimating departures from seasonal rainfall forecasts. The model was applied to the daily rainfall data of Dhaka city in Bangladesh. Dhaka city has a tropical monsoon climate with strong seasonal rainfall characteristics. In this model application, meteorologic data from 1951 to 1980 was used for the determination of seasonal components, and data from 1984 to 1986 were used for regression modeling of deviations. The seasonal modeling was done by fitting Fourier series to the daily normal values of all the variables. The model results were found to be significant for Dhaka city which has a strong seasonal monsoon climate. In the past, no attempts were made to provide quantitative rainfall forecasts for Dhaka city. The usefulness of this model may be well appreciated in other areas with strong seasonal variations and may be used as additional information with weather radar observations and satellite imagery interpretation. (Mertz-PTT)
W91-04127

CLIMATE CHANGE AND CHANGES IN CALIFORNIA SNOWMELT-RUNOFF PATTERNS.
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.
M. Roos.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 507-516, 6 fig, 1 tab.

Descriptors: *California, *Climatic changes, *Global warming, *Runoff, *Snowmelt, *Water use data, Atmospheric circulation, Carbon dioxide, Climatology, Kings River Basin, Sacramento River Basin, San Joaquin River Basin, Snowpack, Water supply.

The scenarios of worldwide warming predicted from global circulation computer modeling of increased atmospheric CO2, if correct, would profoundly affect snowmelt runoff and water supply in the western US. As a result of warmer temperatures, winter term snowline elevations would rise. The higher snow levels would increase winter season rain runoff and reduce snowpack accumulation and cause earlier melt. Water supplies would be affected by the loss of effective natural carryover storage from the winter in the mountain snowpack, unless additional reservoir storage was built to compensate. The estimated natural runoff of California's Sacramento River basin was examined for trends during the past 80 years of record. Since 1950, the contribution of snowmelt (April through July) to the total water year runoff has been decreasing. A similar trend, although not as large, was noted on the higher elevation Kings and San Joaquin River watersheds of the southern Sierra Nevada. (See also W91-04161) (Author's abstract)
W91-04215

ANALYSIS OF ATMOSPHERIC PRECIPITATION BY REVERSED-PHASE ION-PAIR CHROMATOGRAPHY.
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 5A.
W91-04265

NOTE ON THE ATTENUATION OF SURFACE GRAVITY WAVES BY RAINFALL.
Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W91-04298

METEOROLOGICAL FACTORS INFLUENCING THE RADIOACTIVE DEPOSITION IN FINLAND AFTER THE CHERNOBYL ACCIDENT.
Helsinki Univ. (Finland). Dept. of Meteorology.
For primary bibliographic entry see Field 5B.
W91-04430

SMALL TIME AND SPACE MEASUREMENTS OF THE MEAN RAINFALL RATE MADE BY A GAGE NETWORK AND BY A DUAL-POLARIZATION RADAR.
Observatoire de Physique du Globe de Clermont-Ferrand (France).
For primary bibliographic entry see Field 7A.
W91-04431

FREQUENCY-WAVENUMBER SPECTRUM FOR GATE PHASE I RAINFIELDS.
Texas A and M Univ., College Station. Coll. of Geosciences.
S. Nakamoto, J. B. Valdes, and G. R. North.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 842-850, September 1990. 8 fig, 23 ref, NASA Grant NAG-5-869.

Descriptors: *Meteorology, *Rainfall, *Rainfall distribution, *Remote sensing, *Spectral analysis, Atlantic Ocean, Correlation analysis, GATE Phase I, Mathematical models, Model studies, Performance evaluation, Stochastic models, Tropical Rainfall Monitoring Mission.

The oceanic rainfall frequency-wave number spectrum and its associated space-time correlation were evaluated from subsets of Global Atmospheric Research Program Atlantic Experiment (GATE) Phase I data. The records, with a duration of 4 days, were sampled at 15-min intervals in 4 x 4 km grid boxes over a 400-km diameter hexagon. In the low frequencies-low wave number region the results coincide with those obtained by using the stochastic model proposed by North and Nakamoto. From the derived spectrum the inherent time and space scales of the stochastic model were determined to be approximately 13 hr and 36 km. The space-time correlation function evaluated from the frequency-wave number spectrum and that obtained directly from GATE Phase I records agreed. The formalism proposed in 1989 by North and Nakamoto was used together with the derived spectrum to compute the mean square sampling error due to intermittent visits of a spaceborne sensor. The sampling error was estimated to be on the order of 10%, for monthly mean rainfall averaged over 500 x 500 km boxes, which meets the scientific requirements of the Tropical Rainfall Measuring Mission. This result agrees with those previously reported in the literature. (Author's abstract)
W91-04432

RETRIEVAL OF PRECIPITABLE WATER FROM OBSERVATIONS IN THE SPLIT WINDOW OVER VARYING SURFACE TEMPERATURES.
Geophysics Lab. (AFSC), Hanscom AFB, MA.
T. J. Kleespies, and L. M. McMillin.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 851-862, September 1990. 11 fig, 2 tab, 18 ref, append.

Descriptors: *Atmospheric water, *Instrumentation, *Meteorology, *Precipitation, *Remote sensing, *Water vapor, Advanced High Resolution Radiometer, Satellite technology, Split window technique, Temperature, VISSR Atmospheric Sounder.

The split window technique makes use of two differentially absorbing channels in the 11 micrometer region to remove the attenuating effects of atmospheric absorption to achieve a better estimate of the underlying skin temperature than could be produced by a single channel measurement. Since the primary absorber in this region is water vapor, it follows that split window measurements should be able to produce bulk water vapor retrievals as well. When observations are made with split window channels under conditions where the surface contribution to measured radiance changes, but the atmospheric contribution does not, it is possible to estimate the ratio of the transmittance of the two split window channels. This transmittance ratio is related inversely to precipitable water. This technique was applied observations from the Advanced Very High Resolution Radiometer (AVHRR) and the VISSR Atmospheric Sounder (VAS), demonstrating the capability of both instruments to determine precipitable water under two different operational scenarios. Both instruments and both operational modes provided satisfactory results with correlations between ra-

winsonde and satellite determined precipitable water of 0.7 or better. Quite good results, with r = 0.85, a standard difference of 4.4 mm, and n = 60, were achieved with the AVHRR looking at spots that are close in space, but over two different surfaces, such as a river or a lake and the nearby land. The technique was applied to the VAS instrument using a difference in time during the diurnal heating cycle to obtain the change in surface temperature. This case produced good results, with r = 0.92, a standard difference of 3.9 mm, and n = 12, when an independent quality measure was used to eliminate cloud-contaminated retrievals. (Rochester-PTT)
W91-04433

PRECIPITABLE WATER ESTIMATION FROM HIGH-RESOLUTION SPLIT WINDOW RADIANCE MEASUREMENTS.
National Aeronautics and Space Administration, Huntsville, AL. George C. Marshall Space Flight Center.
G. J. Jedlovec.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 863-877, September 1990. 14 fig, 3 tab, 18 ref.

Descriptors: *Atmospheric water, *Instrumentation, *Meteorology, *Precipitation, *Remote sensing, Advanced High Resolution Radiometer, COHMEX day, Multispectral scanner data, Performance evaluation, Temperature, VISSR Atmospheric Sounder.

A technique that uses the spatial variance of image brightness temperature to derive total column precipitable water was applied to high-resolution multispectral aircraft scanner data for the 19 June 1986 Cooperative Huntsville Meteorological Experiment (COHMEX) day. The technique has several advantages over other approaches in that it requires only relative calibration accuracy, is less susceptible to instrument error, and does not use directly a prior information. Results indicate significant horizontal variability of precipitable water at the mesoscale. Precipitable water gradients of 6 mm per 10 km are not uncommon. The results verify well against special rawinsonde measurements and the ensuing cloud field development. While only applied to these specialized aircraft data so far, the technique could be applied to Advanced Very High Resolution Radiometer and VISSR Atmospheric Sounder data. (Author's abstract)
W91-04434

DEFINING HOMOGENEOUS PRECIPITATION REGIONS BY MEANS OF PRINCIPAL COMPONENTS ANALYSIS.
Katholieke Univ. Leuven (Belgium). Lab. for Land Management.
D. Mallants, and J. Feyen.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 892-901, September 1990. 9 fig, 4 tab, 12 ref.

Descriptors: *Belgium, *France, *Meteorology, *Principal component analysis, *Rainfall distribution, *Statistics, Classification, Correlation analysis, Europe, IJzer watershed, Regional analysis, Spatial distribution.

The spatial patterns of precipitation over the IJzer watershed (western Belgium and northern France) were investigated for three years: 1973 (dry), 1977 (wet), and 1978 (average). Analyses were performed using daily precipitation data for the three years together and for the three years separately. The first principal component explains most of the variance (about 75%) and is uniformly distributed over the whole region. Higher-order components delineate subregions of consistent rainfall. No essential difference in pattern in the three years occurs between the first four components. The components patterns seem to express maritime and topographic effects, and form a basis for dividing the IJzer catchment into four coherent subregions. For representative stations inside each subregion, cross correlations with the remaining stations over the entire watershed indicate that at a level of r =* 0.85 three stations define three homogeneous precipitation regions. The result is three representative time series of daily rainfall, one for each region. (Author's abstract)
W91-04435

EFFECT OF SIMULATED ACID RAIN ON REPRODUCTIVE ATTRIBUTES OF RED SPRUCE (PICEA RUBENS SARG).
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Forestry.
For primary bibliographic entry see Field 5C.
W91-04449

RESPONSE OF GROWTH, PHOTOSYNTHESIS, AND MINERAL NUTRITION OF RED SPRUCE SEEDLINGS TO OZONE AND ACIDIC CLOUD DEPOSITION.
Tennessee Valley Authority, Muscle Shoals, AL.
For primary bibliographic entry see Field 5C.
W91-04450

EXPLOITING RAINY SEASON POTENTIAL FROM THE ONSET OF RAINS IN THE SAHELIAN ZONE OF WEST AFRICA.
International Crops Research Inst. for the Semi-Arid Tropics, Niamey (Niger).
For primary bibliographic entry see Field 3F.
W91-04488

PRECIPITABLE WATER IN THE SAHEL MEASURED USING SUN PHOTOMETRY.
National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.
B. N. Holben, and T. F. Eck.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 1/2, p 95-107, August 1990. 8 fig, 2 tab, 13 ref.

Descriptors: *Atmospheric water, *Climatology, *Meteorological data, *Photometry, *Precipitation, *Remote sensing, *Sahel, *Water vapor, Aerosols, Africa, Calibrations, Mali, Maryland, Niger, Precipitation mapping, Radiosondes, Seasonal variation, Spatial distribution.

Information on the mesoscale variability of precipitable water and its relationship with atmospheric aerosol is needed to assess the impact of these atmospheric constituents on the remote sensing of surface parameters from satellite. A sun photometer network in Mali and Niger, Africa, was established in 1984 to measure the temporal and spatial variability of aerosols and water vapor. A new technique was applied to the master calibration instrument based on a Mauna Loa Langley calibration data set. Measurements obtained with the calibrated instrument for 14 days in July 1987 at Goddard Space Flight Center (Greenbelt, MD), retrieved the vertical column precipitable water to within an average of 0.28 cm of the radiosonde measured values under a 2-5 cm precipitable water range and a large range of aerosol optical thicknesses. The calibration was transferred to the sun photometers in the Sahel via intercalibration. Precipitable water retrieved for the Sahelian sites show close agreement with the sparse radiosonde data available and is consistent with published data. The spatial variability of the precipitable water was found to be significantly lower than the aerosol optical depth spatial variability, and there is no correlation between the magnitude of precipitable water and aerosol optical depth. The network shows a dry season monthly average precipitable water value of 1-2 cm and a wet season range of 3.5-4.5 cm. (Author's abstract)
W91-04492

INFLUENCE OF THE BIOSPHERE ON THE GLOBAL CIRCULATION AND HYDROLOGIC CYCLE--A GCM SIMULATION EXPERIMENT.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
Y. C. Sud, P. J. Sellers, Y. Mintz, M. D. Chou, and G. K. Walker.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 1/2, p 133-180, August 1990. 12 fig, 2 tab, 42 ref, append.

Descriptors: *Atmospheric circulation, *Climatology, *General circulation models, *Hydrologic budget, *Meteorology, *Model studies, *Simulation analysis, Deserts, Evapotranspiration, Parametric hydrology, Radiation, Simulated rainfall, Soil surfaces, Tropical regions, Vegetation.

The Simple Biosphere model (SiB) was implemented in the NASA/Goddard Laboratory for Atmospheres (GLA) General Circulation Model (GCM). SiB calculates the land surface fluxes of heat, moisture and momentum, as well as the near-surface fluxes of shortwave and longwave radiation with an explicit parameterization of the interactions among atmosphere, vegetation, and soil processes. Ensemble sets of four July and four January simulations were made with the GLA GCM to evaluate the influence of SiB. Each set contained two runs: one with and one without SiB in the GCM. After allowing an initial adjustment period of about 16 days, the last 31 days of each integration were taken to represent the desired simulation. The results of the SiB vs. no-SiB comparison show that SiB simulates much lower evapotranspiration rates over land and generates significantly different values of surface fluxes for both vegetated and bare soil regions. These differences in the surface fluxes are accompanied by large and statistically significant changes in the simulated rainfall, particularly in the tropics and the summer hemisphere. An analysis of the monthly mean diurnal cycle of surface fluxes shows that both the surface fluxes and rainfall values for the SiB-GCM are realistic in different regions: densely vegetated, sparsely vegetated, and bare soil (including dry deserts). Despite some shortcomings of the SiB-GCM simulations, such as insufficient latitudinal displacement of the ITCZ in both the summer and winter simulations, it is evident that the SiB provides a better estimate of the surface fluxes on the whole, leading to improvements of the simulated circulation and rainfall climatology of the Earth. (Author's abstract)
W91-04493

WORLD GRAIN YIELDS, SNOW COVER, SOLAR ACTIVITY AND QUASI-BIENNIAL OSCILLATION RELATIONSHIPS.
Kansas Univ., Lawrence. Dept. of Physics and Astronomy.
For primary bibliographic entry see Field 3F.
W91-04495

PRECIPITATION AND TEMPERATURE REGIMES IN UPLAND BALOCHISTAN: THEIR INFLUENCE ON RAIN-FED CROP PRODUCTION.
International Center for Agricultural Research in the Dry Areas.
For primary bibliographic entry see Field 3F.
W91-04498

CARBON DIOXIDE AND WATER LEVEL EFFECTS ON YIELD AND WATER USE OF WINTER WHEAT.
Kansas State Univ., Manhattan. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W91-04499

GUELPH RAINFALL SIMULATOR II: PART 1. SIMULATED RAINFALL CHARACTERISTICS.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
R. W. Tossell, G. J. Wall, W. T. Dickinson, R. P. Rudra, and P. H. Groenevelt.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 205-213, July 1990. 4 fig, 8 tab, 20 ref.

Descriptors: *Canada, *Rainfall distribution, *Rainfall intensity, *Rainfall simulators, *Simulated rainfall, Distribution, Fluid drops, Kinetic energy, Mathematical equations, Momentum equation, Nozzles, Soil erosion, Velocity distribution.

There are several types and designs of rainfall simulators used in soil erosion and infiltration stud-

ies, providing some control of rainfall characteristics. The Guelph Rainfall Simulator II (GRS II) is a portable device which was designed and developed for microscale laboratory and field soil erosion studies. Rainfall characteristics of the GRS II were evaluated using an optical extinction technique. Rainfall properties examined included rainfall intensity, drop size distribution, drop velocity distribution, momentum and kinetic energy. Three nozzle sizes, three nozzle heights, and three locations within the spray were studied for their effect on rainfall properties. Drop size distributions and drop velocity distributions were related to nozzle size, while momentum and kinetic energy were related to rainfall intensity. Measured simulated rainfall intensities ranged from approximately 16 mm/hr to in excess of 350 mm/hr depending on spray location. Simulated rainfall kinetic energy ranged from a low value of 0.0199 to approximately 1.83 J/sq-m/s. The gamma distribution equation, used to predict simulated rainfall drop size distribution, provides good estimates of rainfall properties for all drop diameters. A large proportion of the total momentum and kinetic energy is associated with the larger drop diameters. The gamma distribution, in conjunction with a velocity predictive equation, supplies information on both momentum flux density and kinetic energy flux density. The velocity predictive equation has proven to be equally valuable in predicting the velocity of simulated droplets, particularly for the large drop sizes where estimates are based on a small sample size. (See also W91-04548) (Author's abstract)
W91-04547

GUELPH RAINFALL SIMULATOR II: PART 2. A COMPARISON OF NATURAL AND SIMULATED RAINFALL CHARACTERISTICS.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
R. W. Tossell, G. J. Wall, W. T. Dickinson, R. P. Rudra, and P. H. Groenevelt.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p , July 1990.

Descriptors: *Canada, *Rainfall distribution, *Rainfall intensity, *Rainfall simulators, *Simulated rainfall, Fluid drops, Kinetic energy, Momentum, Performance evaluation, Storms, Velocity distribution.

The performance of a rainfall simulator is generally measured by its ability to produce characteristics similar to those of natural rainfall. In the past, direct comparison between natural and simulated rainfall has been limited to parameters such as rainfall intensity and rainfall spatial uniformity. However, a comprehensive comparison of rainfall properties should include rainfall intensity, spatial uniformity, drop size distribution (DSD), drop velocity distribution (DVD), momentum and/or kinetic energy. Properties of simulated rainfall generated by the Guelph Rainfall Simulator II (GRS II) were compared with the properties of natural rainfall. Properties examined include: DSD, DVD, liquid water content, momentum, and kinetic energy flux density. Comparison with the limited DSD data of high intensity natural storms show that the GRS II simulated rainfall has DSD characteristics similar to natural rainfall through the mid to large drop size ranges (diameter > 1.50 mm). The simulated rainfall has greater counts of small drops (diameter < 2.00 mm), as compared to natural rainfall; and simulated drop velocities are generally lower than the terminal velocities of natural rainfall, resulting in lower values of momentum and kinetic energy than those of natural rainfall. (See also W91-04547) (Author's abstract)
W91-04548

FLOOD OF APRIL 4-5, 1987, IN SOUTHEASTERN NEW YORK STATE, WITH FLOOD PROFILES OF SCHOHARIE CREEK.
Geological Survey, Albany, NY.
For primary bibliographic entry see Field 2E.
W91-04645

EFFECTS OF ACID PRECIPITATION ON REPRODUCTION IN BIRDS.
Instituut voor Oecologisch Onderzoek, Heteren (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04774

EFFECT OF ANTECEDENT SOIL MOISTURE ON SPLASH DETACHMENT UNDER SIMULATED RAINFALL.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.
For primary bibliographic entry see Field 2J.
W91-04800

SPATIAL VARIATION OF RAINFALL INTENSITIES FOR SHORT DURATION STORMS.
University of the Witwatersrand, Johannesburg (South Africa). Water Systems Research Programme.
N. A. Patrick, and D. Stephenson.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 667-680, December 1990. 8 fig, 16 ref.

Descriptors: *Rain gages, *Rainfall, *Rainfall distribution, *Rainfall intensity, *South Africa, *Storms, Computer models, Data collections, Model studies, Simulated rainfall, Storm runoff, Storm water.

Rainfall data for estimating either runoff or infiltration are usually obtained from sparse raingauge networks. Frequently a single raingauge representing a large area is used to estimate point rainfall, and factors are applied to obtain spatially averaged rainfall. The use of autographic raingauges and data loggers enables the accurate temporal distribution of rainfall to be measured, but this is based on point measurements from the raingauges. The limited areal extent and evolving nature of convection storms over a small catchment near Johannesburg were investigated and an analysis of 21 storm events over the 10.4 square km suburban catchment was carried out. Five autographic raingauges with mechanical loggers were used to study the spatial distribution of short duration storms. Shapes of storms were modeled by a numerical surface fitting technique chosen after several alternative methods were compared for suitability. A model was developed, utilizing the chosen inverse squared distance technique, which enabled storm intensities to be simulated over the study catchment. The results of the study suggest that a spatial description of storm events at discrete time steps is a valuable approach for understanding the cellular composition of storm events and that the spatial variability of storms should be incorporated when studying the rainfall-runoff process. (Mertz-PTT)
W91-04806

APPROXIMATE ANALYTICAL SOLUTIONS FOR OVERLAND FLOWS.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-04919

REGIONAL SURFACE FLUXES FROM REMOTELY SENSED SKIN TEMPERATURE AND LOWER BOUNDARY LAYER MEASUREMENTS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
M. Sugita, and W. Brutsaert.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2937-2944, December 1990. 7 fig, 2 tab, 15 ref. NSF Grant ATM-8619193.

Descriptors: *Atmospheric physics, *Boundary layers, *Climatology, *Kansas, *Remote sensing, *Temperature, Climates, Evaporation, Heat flow, Satellite technology, Seasonal distribution, Solar radiation, Vegetation effects.

During the First International Satellite Land Surface Climatology Project Field Experiment in northeastern Kansas, surface temperature was measured by infrared radiation thermometers at some 12 stations spread over the 15 x 15 km experimental area. These data, together with wind and temperature profiles in the unstable atmospheric boundary layer measured by means of radiosondes, corresponding to the radiometric surface temperature was found to increase as the season progressed; for the spring campaign the mean value z-oh,r = .000000456 m and for the fall z-oh,r = .0101 m. The radiometric scalar roughness could also be expressed as a function of solar elevation and to a lesser extent, of canopy height or leaf area index. For an elevation range 10 degrees <= alpha <= 75 degrees the regression equation is z-oh,r = exp (-0.735-3.61 tan (alpha)). With this function good agreement (r = 0.87) was obtained between the profile-derived regional surface flux of sensible heat and the mean flux measured independently at ground-based stations under unstable conditions. Similarly, regional values of evaporation, obtained by means of the energy budget method from these sensible heat flux estimates, were in good agreement (r = 0.96). (Author's abstract)
W91-04923

MECHANISMS AFFECTING STREAMFLOW AND STREAM WATER QUALITY: AN APPROACH VIA STABLE ISOTOPE, HYDROGEOCHEMICAL, AND TIME SERIES ANALYSIS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W91-04929

HYDROGEOCHEMICAL RESPONSE OF A FORESTED WATERSHED TO STORMS: EFFECTS OF PREFERENTIAL FLOW ALONG SHALLOW AND DEEP PATHWAYS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2E.
W91-04930

2C. Snow, Ice, and Frost

SATELLITE REMOTE SENSING FOR HYDROLOGICAL MONITORING AND WATER MANAGEMENT IN GREAT BRITAIN.
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W91-03956

SNOW COVER-SUMMER MONSOON RAINFALL OVER PARTS OF SAHEL.
Nairobi Univ. (Kenya).
For primary bibliographic entry see Field 7B.
W91-03967

RECHARGE PROCESSES DURING SNOWMELT: AN ISOTOPIC AND HYDROMETRIC INVESTIGATION.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W91-04103

ABLATION OF AVALANCHED AND UNDISTURBED SNOW, HIMALAYA MOUNTAINS, PAKISTAN.
Okanagan Coll., Kelowna (British Columbia). Dept. of Geography.
F. A. de Scally, and J. S. Gardner.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2757-2767, November 1990. 7 fig, 3 tab, 64 ref.

Descriptors: *Ablation, *Avalanches, *Himalayan Mountains, *Pakistan, *Runoff, *Runoff forecasting, *Snowmelt, Condensation, Melting, New snow, Temperature.

Avalanche deposits represent a significant storage of winter snow on the south slope of the Himalaya Mountains, Pakistan, complicating the annual snowmelt cycle because of the differences in ablation of avalanche-transported snow and undisturbed snow. Measurements show very high rates of melting of both snow types, particularly of

avalanche snow late in the melt season. These high rates are a function of the low latitude of the study area and the low elevation of the avalanche snow deposits, as well as heat release by condensation. Air temperature was closely correlated with daily snowmelt and appears to hold promise as a predictor; however, data constraints prevent an energy balance analysis of this relationship. Gravimetric measurements show that condensation is important in the snow surface energy exchange and can represent a significant contribution to snowmelt. Rainfall during warm conditions also makes a more significant contribution to snowmelt than shown in previous studies. The derived temperature-based melt factors or coefficients compare well with published figures from other mountain areas, but their confidence limits are sufficiently wide to produce significant errors in the prediction of basin snowmelt runoff. (Author's abstract)
W91-04129

MICRO-INVERTEBRATE COMMUNITY STRUCTURE WITHIN A MARITIME ANTARCTIC LAKE.
British Antarctic Survey, Cambridge (England).
For primary bibliographic entry see Field 2H.
W91-04532

SEASONAL CHANGES OF WATER TEMPERATURE AND CHLOROPHYLL CONCENTRATION IN LAKE O-IKE.
National Inst. of Polar Research, Tokyo (Japan).
For primary bibliographic entry see Field 2H.
W91-04534

HYDROLOGIC FLOW PATH DEFINITION AND PARTITIONING OF SPRING MELTWATER.
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
For primary bibliographic entry see Field 5B.
W91-04925

2D. Evaporation and Transpiration

ADVECTIVE MIXED-LAYER MODEL FOR HEAT AND MOISTURE INCORPORATING AN ANALYTIC EXPRESSION FOR MOISTURE ENTRAINMENT.
British Columbia Univ., Vancouver. Dept. of Geography.
D. G. Steyn.
Boundary Layer Meteorology BLMEBR, Vol. 53, No. 1/2, p 21-31, October 1990. 5 fig, 2 tab, 12 ref.

Descriptors: *Advection, *Air-earth interfaces, *Atmospheric physics, *Boundary processes, *Energy dissipation, *Entrainment, *Evaporation, *Model studies, *Moisture content, Heat flow, Heat transfer, Humidity, Mathematical models, Temperature, Turbulence, Vertical flow.

Evaporation from the Earth's surface is limited by the availability of energy and moisture at the surface and by the capacity of the overlying atmosphere to assimilate moisture. When the surface layer and the overlying mixed layer are closely linked, the vapor pressure deficit, which is a function of the moisture content and temperature of the mixed layer, becomes an important factor in controlling evaporation. A slab mixed-layer model with zero-order entrainment for both temperature and humidity is developed to examine the relative magnitude of advective and turbulence flux convergence effects. The model formulation provides an analytic function for the ratio of surface-layer to entrainment-layer humidity flux. Model results are compared with measured mixed-layer properties over one day at a coastal location. The model is highly successful at simulating the mixed-layer depth, and mean mixed-layer humidity. A first-order model may be more appropriate for the latter half of the day when the mixed-layer depth is decreasing due to the dominance of advection over vertical turbulence flux convergence. (Author's abstract)
W91-04014

EVAPOTRANSPIRATION FROM SEDGE-DOMINATED WETLAND SURFACES.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
P. M. LaFleur.
Aquatic Botany AQBODS, Vol. 37, No. 4, p 341-353, September 1990. 5 fig, 3 tab, 16 ref.

Descriptors: *Evapotranspiration, *Limnology, *Marsh plants, *Subarctic zone, *Vegetation effects, *Wetlands, Canada, Fens, Mathematical models, Ontario, Regression analysis.

The evapotranspiration regimes of two sedge communities in a subarctic coastal fen wetland on southern James Bay (Ontario, Canada) were investigated during non-vegetated periods. In this region an emergent coastline has produced a series of low beach ridges running roughly parallel to the coast and separated by poorly-drained marsh depressions. One study site (the 'dry' site) was on the elevated backshore zone about 500 m from the mean high tide (MHT) mark, and the second (the 'wet' site) was 1100 m inland from the MHT mark, situated in an inter-ridge depression. Surface moisture availability strongly controlled evapotranspiration during non-vegetated conditions, but was less important during the vegetated period. The results suggest that the evaporation efficiency of these sites changed in response to vegetation growth. Vegetation cover reduced the evaporating efficiency of the wet site and slightly increased evaporation efficiency of the dry site. Simple linear regression models based on Penman's open water evaporation formula were found to predict evapotranspiration accurately at each site under all surface cover conditions. However, model coefficients for the two sites differed substantially. Dividing the dataset into non-vegetated and vegetated periods improved the model performance only marginally. (Fleishman-PTT)
W91-04051

MAPPING EVAPOTRANSPIRATION USING THE ENERGY-BUDGET METHOD WITH REMOTELY SENSED DATA.
Geological Survey, Phoenix, AZ. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-04231

ESTIMATION OF RESERVOIR SURFACE AREAS USING SATELLITE IMAGERY, UPPER GUNNISON RIVER BASIN, COLORADO.
Bureau of Reclamation, Denver, CO.
D. W. Eckhardt, and D. W. Litke.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 691-702, 3 fig, 4 tab, 6 ref.

Descriptors: *Evaporation, *Gunnison River Basin, *Mapping, *Reservoirs, *Satellite technology, *Surface water data, *Water use data, Aerial photography, Colorado, Data acquisition, Data interpretation, Digital map data, Evapotranspiration, Landsat images, Maps, Water loss, Water resources data.

Accurate surface area data for reservoirs are needed to estimate evaporative water losses. Surface areas of reservoirs in the Upper Gunnison River basin in south central Colorado were estimated by using 20 meter resolution SPOT (Systeme Probatoire d'Observation de la Terre) HRV (High Resolution Visible) and 57 meter resolution Landsat 5 MSS (Multispectral Scanner) digital image data. Image maps of surface area were generated from both image data sets by using a subpixel water proportion estimating. Reservoir surface area data from area/elevation tables were used for technique calibration. Several hundred water bodies were identified within the study area, of which 37 were identified as reservoirs. Reservoir surface areas ranged from 0.2 to 3,578 hectares, and the cumulative surface area was 6,129 hectares. Estimated reservoir surface areas at 15 sites agreed with reported surface areas within 7.0%. A gross annual evaporative rate of 84 to 108 centimeters (dependent on reservoir location) was applied to each surface area to calculate gross evaporative loss. Total gross evaporative loss from reservoirs in the basin was estimated to be 57,490,000 cu m. (See also W91-04161) (Author's abstract)
W91-04234

METHODS TO CONVERT AMERICAN CLASS A-PAN AND SYMON'S TANK EVAPORATION TO THAT OF A REPRESENTATIVE ENVIRONMENT.
Hydrological Research Inst., Pretoria (South Africa).
H. H. Bosman.
Water SA WASADV, Vol. 16, No. 4, p 227-236, October 1990. 5 fig, 7 tab, 23 ref.

Descriptors: *Analytical methods, *Data interpretation, *Evaporation, *Evaporimeters, *Pan evaporation, *Semiarid climates, Evaporation pans, Evaporation rate, Regression analysis, Roodeplaat Dam, South Africa.

Methods were introduced to correct for significant evaporation differences which resulted from non-representative environmental evaporimeter installation practices. The investigation of different installation practices was applied to American Class A-pan and Symon's tanks at Roodeplaat Dam, a semi-arid region which represents the climate of a large part of South Africa. Statistically significant differences in evaporation were introduced by non-standard environmental installation practices. Linear regression conversion formulae were used to correct the evaporation rates of the different evaporimeters to comply with that of a representative environment. The differences in evaporation between stations in close proximity were nonexistent after monthly evaporation data were corrected using the conversion formulae. Recommendations for maintaining a representative environment around the evaporation station included maintaining the a similar cover to the natural cover common to the area, cutting grass and weeds to keep them below the level of the pan rim, and avoiding placement of the evaporimeter on a concrete slab, asphalt, or layer of crushed rock. (MacKeen-PTT)
W91-04314

MONITORING MOISTURE STORAGE IN TREES USING TIME DOMAIN REFLECTOMETRY.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2I.
W91-04388

ESTIMATION OF TRANSPIRATION BY SINGLE TREES: COMPARISON OF A VENTILATED CHAMBER, LEAF ENERGY BUDGETS AND A COMBINATION EQUATION.
Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Div. of Forestry and Forest Products.
R. Leuning, and I. J. Foster.
Agricultural and Forest Meteorology AFMEEB, Vol. 51, No. 1, p 63-86, June 01, 1990. 11 fig, 1 tab, 26 ref.

Descriptors: *Forestry, *Leaves, *Transpiration, *Water use, Energy, Estimating equations, Eucalyptus trees, Forest hydrology, Forest management, Forest watersheds, Vegetation effects, Watershed management.

Selection of vegetation type for differing rates of water use provides a potentially powerful tool in catchment management. The validity of transpiration rates measured by ventilated chambers (VCs) was assessed using two techniques which could be applied both with and without the VC in place. The Penman-Monteith (P-M) equation, applied to single leaves of the Eucalyptus species, provided one set of transpiration estimates for both VC positions. A second set was obtained using a leaf energy budget method which utilized paired leaves, one of which was prevented from transpiring, while the other behaved normally. Temperature differences between the two leaves and boundary layer conductances measured in situ were used to estimate transpiration rates for

normal leaves through solution of leaf energy budget equations. Transpiration rates within the VC were reduced by up to 30% around midday relative to undisturbed conditions, according to estimates using the P-M equation. Enhanced transpiration during late afternoon was also predicted. Diminished transpiration rates within the VC were caused by a marked reduction in available energy when the VC walls were raised. Leaf energy budget measurements on 9-12 paired leaves did not confirm predictions from the P-M equation that transpiration rates within the VC were lower than under natural conditions. Midday transpiration measurements from leaf energy budgets were 25% higher than P-M predictions when the VC was in position and 25% lower when it was down, thus suggesting little change in transpiration rates with VC position. Small differences in transpiration rates between trees cannot readily be resolved by any of the estimation techniques used because of inherent uncertainties in each method. (Author's abstract)
W91-04484

BELLANI EVAPORATION VARIATION IN HILL-LAND PASTURE.
Agricultural Research Service, Beckley, WV. Appalachian Soil and Water Conservation Research Lab.
C. M. Feldhake, and D. G. Boyer.
Agricultural and Forest Meteorology AFMEEB, Vol. 51, No. 3/4, p 211-222, July 1990. 6 fig, 1 tab, 26 ref.

Descriptors: *Agricultural hydrology, *Evaporation, *Evaporimeters, *Microclimatology, *Pasture management, *Soil-water-plant relationships, Appalachian Region, Available water, Evaporation rate, Pastures, Physiographic effects, Soil moisture, Solar radiation, Water stress, Wind.

In the Appalachian region, pasture production is frequently limited by water availability, a parameter strongly influenced by microclimate variability. A study was conducted to determine the magnitude of potential evaporation variability across a hilly pasture on a seasonal basis. A steep pasture watershed was instrumented at 32 sites with a black and white Bellani plate evaporimeters. Evaporation was measured during the summers of 1985, 1986, and 1987. Average potential evaporation, assessed by readings from black plate evaporimeters, ranged from 4.5 to 6.1 mm/day (36%) averaged over the frost-free period, June-September. Over the same period and across the same area, solar radiation was estimated to vary from 11.9 to 16.9 MJ/sq m (34%), and wind from 50 to 131 km/day (164%). The data predict a substantial spatial difference in forage water stress owing to differences in soil moisture depletion rate. These substantial microclimate differences suggest the importance of developing management practices suited to specific sites within hilly pastures. (Author's abstract)
W91-04486

ESTIMATING EVAPORATION FROM PASTURE USING INFRARED THERMOMETRY: EVALUATION OF A ONE-LAYER RESISTANCE MODEL.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
J. D. Kalma, and D. L. B. Jupp.
Agricultural and Forest Meteorology AFMEEB, Vol. 51, No. 3/4, p 223-246, July 1990. 9 fig, 1 tab, 32 ref.

Descriptors: *Agricultural hydrology, *Evaporation, *Model studies, *Radiometry, *Soil-water-plant relationships, Air temperature, Australia, Canopy, Estimating equations, Heat balance, Infrared radiation, Model testing, Pasture management, Performance evaluation, Resistance, Soil temperature, Thermometers, Vegetation effects.

A one-layer resistance model was used with infrared thermometry to estimate sensible and latent heat flux in pastures near Goulburn, New South Wales, Australia. The model compares reasonably well with energy balance-Bowen ratio measurements. However, the relative error in the evaporation estimates becomes significant in very dry conditions and at low net radiation values. An aerodynamic surface temperature may be computed from independent sensible heat flux measurements, air temperature measurements, and estimates of aerodynamic resistance. The differences between computed and observed surface temperatures show characteristic diurnal trends and vary between days of measurement. These differences may be caused by errors in measuring the sensible heat flux and the surface temperature and in estimating the aerodynamic resistance. The pasture data obtained was used to assess such uncertainties. The major cause for differences between the computed and observed surface temperatures was found to be the incompleteness of the vegetative cover during each of the experimental periods. The measured surface temperature values apply to both the vegetation and the soil surface, whereas the observed aerodynamic values are based on a model which assumes complete cover and only considers foliage temperature. Finally, a one-dimensional, two-layer model was used to show that the relationship between the measured infrared surface temperature and the canopy air temperature depends on the aerodynamic resistances, the fractional vegetated area and the temperature differences between foliage, canopy air, and soil surface. (Author's abstract)
W91-04487

STOMATAL RESISTANCE MODEL ILLUSTRATING PLANT VS. EXTERNAL CONTROL OF TRANSPIRATION.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
B. H. Lynn, and T. N. Carlson.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 1/2, p 5-43, August 1990. 16 fig, 5 tab, 87 ref, append. National Aeronautics and Space Administration grant NAG 5-919; United States Geological Survey grant no. 14-08-0001-G1490; United States Department of Agriculture/Agricultural Research Service grant no. 58-32U4-8-27.

Descriptors: *Evapotranspiration, *Leaves, *Model studies, *Soil-water-plant relationships, *Stomatal transpiration, Atmospheric water, Boundary layers, Canopy, Plant physiology, Resistance, Roots, Soil water, Solar radiation, Vapor pressure.

Evapotranspiration is highly dependent upon the resistance exerted by the plant on the flow of water from soil to atmosphere. Stomatal resistance is correlated with a number of factors: short-term changes in leaf water potential, significant drying of the soil, vapor pressure deficit, solar flux, leaf temperature, and ambient carbon dioxide. It has also been proposed that there is an additional dependence of stomatal resistance on soil water potential, caused by the transport of cytokinins from the root in response to soil drying. In order to express the relationship between these factors and stomatal resistance, it is necessary to combine them in a deterministic manner. A stomatal resistance model is proposed that is specifically designed for use within atmospheric boundary layer models. Stomatal resistance is expressed as a product of linear discontinuous functions of leaf water potential and solar flux; vapor pressure deficit is included indirectly by allowing for a gradient of leaf water potential between the surface and interior of the leaf. An important assumption is that stomatal resistance increases sharply beyond a critical value of leaf water potential and/or critical solar flux. The model is able to simulate a transpiration plateau; this plateau may occur because of high atmospheric demand and/or a limitation in soil water. Transpiration (and radiometric canopy temperature) is tied not just to the supply of moisture in the root zone and atmospheric demand, but to constraints imposed by plant physiology which affects water flux through the plant. (Fish-PTT)
W91-04489

IMPROVED PROSPECTS FOR ESTIMATING INSOLATION FOR CALCULATING REGIONAL EVAPOTRANSPIRATION FROM REMOTELY SENSED DATA.
Maryland Univ., College Park. Dept. of Meteorology.
R. T. Pinker, and I. Laszlo.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 1/2, p 227-251, August 1990. 9 fig, 7 tab, 47 ref, 2 append. National Aeronautics and Space Administration (NASA), Earth Science and Applications Division, Land Processes Branch Grant NAG-5-812; NASA, Earth Science and Applications Division, Climate Research Program Grant NAG-5-914.

Descriptors: *Climatology, *Evapotranspiration, *Meteorological data collection, *Remote sensing, *Solar radiation, Albedo, Error analysis, Estimating equations, Primary productivity, Satellite technology.

To understand climate on various spatial and temporal scales, information on solar radiation reaching the ground is required. Insolation is a key parameter in most formulations for estimating regional evapotranspiration and/or primary productivity. Many attempts have been made to replace several parameters in these formulations with remotely sensed data. Insolation, however, has been obtained from conventional observations. Satellite methods for deriving insolation can be improved on the regional scale beyond what is achievable on large scales. A realistic surface albedo model has been developed, which was used as an improved boundary condition in an insolation model, and also to specify clear/cloudy thresholds. It was demonstrated that as a result, the mean bias error (MBE) was reduced by as much as 50%, to about 6 W/sq m for a monthly mean. Such improvements and accuracies show that it is possible to improve the performance of an insolation model by selecting the best local climatology; by incorporating improved clear/cloudy thresholds, based on local monthly or seasonal background brightness models; and that the quality of presently available satellite observations plays a major role in research aimed at extracting climate parameters from such observations. (Fish-PTT)
W91-04490

DETERMINATION OF SOIL WATER EVAPORATION AND TRANSPIRATION FROM ENERGY BALANCE AND STEM FLOW MEASUREMENTS.
Kansas State Univ., Manhattan. Dept. of Agronomy.
J. M. Ham, J. L. Heilman, and R. J. Lascano.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 3/4, p 287-301, September 1990. 6 fig, 3 tab, 23 ref.

Descriptors: *Analytical techniques, *Energy, *Evapotranspiration, *Evapotranspiration control, *Hydrologic budget, *Land management, *Soil-water-plant relationships, *Stemflow, Bowen ratio, Cotton, Cover crops, Cropland, Evaporation, Evaporation area, Heat balance, Lysimeters, Soil water potential, Texas, Transpiration.

Frequent measurements of soil water evaporation (E) and transpiration (T) are needed to quantify energy and water balances of sparse crops. Field experiments were conducted in Lubbock, Texas, to examine the feasibility of partitioning evapotranspiration (ET) from a cotton crop during periods of partial cover. The Bowen ratio energy balance method and heat balance stemflow measurements were used to make near-instantaneous measurements of ET and T, respectively. Transpiration on a unit land area basis was determined by normalizing stemflow measurements by leaf area or plant density. Soil water evaporation was computed as the difference between ET and T. The accuracy of the method was evaluated by comparing calculated values of E with measured values obtained from soil microlysimeters. Measurements over an 8-day period following an irrigation indicated that daily values of calculated E were within 0.5 mm of measured values in six out of seven comparisons when stemflow measurements were normalized on a leaf area basis. On average, daily calculated E was within 11% of measured values. Calculated and measured cumulative E agreed to within 0.6 mm at the end of the evaluation period. Computing

T by normalizing stemflow on a plant density basis resulted in overestimates of T and underestimates of E. Error analysis indicates that the precision of the E estimate decreases rapidly as evaporation becomes a smaller fraction of ET, and is influenced equally by the resolution of the stemflow and leaf area measurements. This study demonstrates that high frequency, independent measurements of soil and canopy evaporation can be obtained by measurement of ET and stemflow. (Author's abstract)
W91-04496

EVAPOTRANSPIRATION AND YIELD OF IRRIGATED CHICKPEA.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
P. Singh, and S. M. Virmani.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 3/4, p 333-345, September 1990. 4 fig, 6 tab, 18 ref.

Descriptors: *Crop yield, *Evapotranspiration, *Legumes, *Plant growth, *Plant-water relationships, *Water management, *Water stress, Irrigation, Model studies, Prediction, Regression analysis, Seeds, Vapor pressure.

Field experiments were conducted during the 1986 and 1987 post-rainy seasons to relate total above-ground dry matter (TDM) and seed yields of chickpea (Cicer arietinum L.) with evapotranspiration (ET). The crop was subjected to various degrees of water stress by applying gradient irrigations during three growth phases: emergence to 50% flowering; 50% flowering to 50% beginning pod-fill; and 50% beginning pod-fill to physiological maturity. Analysis of the 2-year pooled data showed that across seasons both TDM and seed yields were more strongly correlated with normalized ET, defined as ratio of actual ET to saturation vapor pressure deficit of air, than with actual ET. Partitioning of total normalized ET observed during the season into normalized ET observed during two or three growth phases of chickpea and regressing seed yield against them did not improve the predictability of models. It was concluded that both TDM production and seed yield responses of chickpea to water management can be predicted if the normalized ET during the season is known. (Author's abstract)
W91-04497

DIURNAL VARIATION OF CROP HYDRAULIC RESISTANCE: A NEW ANALYSIS.
Hawke's Bay Agricultural Research Centre, Hastings (New Zealand).
J. B. Reid, and M. G. Huck.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 827-834, July/August 1990. 9 fig, 1 tab, 37 ref.

Descriptors: *Agronomy, *Crop production, *Diurnal variation, *Evapotranspiration, *Plant water potential, *Soil-water-plant relationships, Clays, Hydrologic equation, Leaves, Loam, Moisture uptake, Roots, Soil water potential, Transpiration.

Several explanations have been advanced to account for the apparent diurnal variation in crop hydraulic resistance calculated from a simple Ohm's Law analog. It is suggested that crop resistance calculated in this way may vary because of spatial variation in soil water potential. It is proposed that whenever transpiration rate is small and leaf water potential is relatively high, roots extract water mainly from those regions of the soil profile where soil water potential is also high (usually deep in the profile). As transpiration rate increases and leaf water potential becomes more negative, roots begin removing water from regions of the profile where soil water potential is more negative. Hence, the length of roots actually taking up water at a particular time, and therefore crop resistance, may vary diurnally. Also, variations in soil water potential and rooting density often make the relation between leaf water potential and water uptake rate unique for each soil region. So, even when all roots are taking up water, leaf water potential and the aggregated uptake rate may be nonlinearly related, and crop resistance will vary diurnally with leaf water potential. Exploratory calculations of crop resistance illustrated this theory for temperate crops grown in three different soils (a clay, a silt loam, and a sandy loam), with various combinations of root system properties and evapotranspiration rates. Although soil water potential was initially distributed uniformly, heterogeneity in root distribution soon caused spatial variation in soil water potential, and crop resistance showed marked diurnal variations. Variation in crop resistance increased with the predicted variation in soil water potential. (Author's abstract)
W91-04503

GEOHYDROLOGY, WATER QUALITY, AND WATER BUDGETS OF GOLDEN GATE PARK AND THE LAKE MERCED AREA IN THE WESTERN PART OF SAN FRANCISCO, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04883

INNER REGION HUMIDITY CHARACTERISTICS OF THE NEUTRAL BOUNDARY LAYER OVER PRAIRIE TERRAIN.
Cornell Univ., Ithaca, NY.
W. Brutsaert, M. Sugita, and L. J. Fritschen.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2931-2936, December 1990. 6 fig, 3 tab, 11 ref. NSF Grant ATM-8619193.

Descriptors: *Atmospheric physics, *Boundary layers, *Climatology, *Humidity, *Kansas, *Prairies, Climates, Evaporation, Radiosondes, Remote sensing, Satellite technology, Water vapor.

Radiosonde observations were carried out over prairie terrain in the Flint Hills region of eastern Kansas during the First International Satellite Land Surface Climatology Project Field Experiment experiments in 1987. Analysis of 13 specific humidity profiles measured under neutral conditions revealed that they can be described by a logarithmic dependency on (z-d-o), where z is the height above the zero-plane reference at 330 m above sea level and d-o = 26.9 m the assumed displacement height. With a roughness height z-o = 1.05 m, this logarithmic layer was found to occupy the range 52 (=/-28) <= (z-d-o)/z-o < = 104 (+/-37), which is consistent with previous experiment results. Good agreement was obtained (r = 0.87) between the evaporation values derived from the radiosonde profiles and mean values determined independently at six ground stations distributed over the 15 x 15 km experimental region. On the basis of only one profile the scalar roughness for water vapor z-ov was found to be 3 to 5 orders of magnitude smaller than z-o. (Author's abstract)
W91-04922

REGIONAL SURFACE FLUXES FROM REMOTELY SENSED SKIN TEMPERATURE AND LOWER BOUNDARY LAYER MEASUREMENTS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W91-04923

2E. Streamflow and Runoff

DIGITAL ELEVATION MODELS AND THEIR APPLICATION TO REMOTE SENSING OF WATER RESOURCES.
Aston Univ., Birmingham (England). Remote Sensing Unit.
For primary bibliographic entry see Field 7C.
W91-03959

FINITE ELEMENT WATERSHED MODELING: ONE-DIMENSIONAL ELEMENTS.
Michigan State Univ., East Lansing. Dept. of Agricultural Engineering.
B. E. Vieux, V. F. Bralts, L. J. Segerlind, and R. B. Wallace.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 803-819, November/December 1990. 4 fig, 15 ref, 2 append.

Descriptors: *Kinematic wave theory, *Model studies, *Overland flow, *Rainfall-runoff relationships, *Watershed management, *Watersheds, Flow depth, Flow rates, Hydraulic roughness, Hydrographs, Spatial distribution, Temporal distribution, Wave equations.

The kinematic wave equations are the governing equations for overland flow and channel flow under certain conditions. Upland reaches of natural watersheds and small man-made surfaces are dominated by overland-flow processes. The kinematic wave equations may be applied to overland flow under most practical situations encountered in water management. A procedure for calculating the spatial and temporal distribution of a direct runoff hydrograph from an ungauged watershed is presented, with nodal values of hydraulic roughness and slope used to avoid kinematic shock. This formulation allows the simulation of overland flow over spatially variable surfaces typical of natural watersheds. The procedure is compared to an analytic solution for a simple case of a watershed composed of two planes. Broader application to watersheds with spatially variable parameters is possible because of the flexibility of the finite element. The Galerkin formulation of the finite element method is used to solve the kinematic wave equations. The method of characteristic and the finite element method were compared on a two-plane system with an abrupt change in slope. The numerical and analytical considerations are presented to enable practicing engineers to adopt this method for the calculation of flow depth and discharge rate in a distributed manner throughout a watershed dominated by overland flow. (Author's abstract)
W91-03993

DENITRIFICATION AND PHOTOSYNTHESIS IN STREAM SEDIMENT STUDIED WITH MICROSENSOR AND WHOLE-CORE TECHNIQUES.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2H.
W91-03999

MODELLING THE CONSUMPTION OF DISSOLVED CONTAMINANTS BY BIOFILM PERIPHYTON IN OPEN-CHANNEL FLOW.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W91-04082

PREDICTION OF THE TEMPERATURE DEPENDENCE OF ELECTRICAL CONDUCTANCE FOR RIVER WATERS.
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 7B.
W91-04086

ROLE OF HYPSOMETRY AND PLANFORM IN BASIN HYDROLOGIC RESPONSE.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
A. D. Howard.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 373-385, October/December 1990. 3 fig, 1 tab, 66 ref.

Descriptors: *Drainage patterns, *Flood hydrographs, *Flood routing, *Geomorphology, *Rainfall-runoff relationships, *Routing, *Simulation analysis, Flood peak, Hydrologic models.

The effects of variations of drainage basin morphometry and relief characteristics on flood peak magnitude and time-to-peak were investigated using simulated stream networks. The networks are produced by three models: headward growth, systematic capture, and minimum power relax-

ation. Translational and kinematic wave flood routing were used to generate synthetic hydrographs. Peak discharge and time-to-peak are predictable to a high degree by five different sets of morphometric-relief parameters. In order of decreasing order of importance in predictive ability the parameters characterize basin size, relative relief, basin concavity, and basin shape. Both simulated and natural stream networks exhibit strong dependence of planimetric morphometry upon basin concavity. The effect of this dependency is to increase the effect of basin concavity upon flood hydrographs. (Author's abstract)
W91-04105

HOLOCENE HISTORY OF THE EL NINO PHENOMENON AS RECORDED IN FLOOD SEDIMENTS OF NORTHERN COASTAL PERU.
California Univ., Berkeley. Dept. of Geography.
For primary bibliographic entry see Field 2B.
W91-04109

ASSESSMENT OF RUNOFF AND SUSPENDED SEDIMENT YIELD IN A PARTIALLY FORESTED CATCHMENT IN SOUTHERN CHILE.
Universidad Austral de Chile, Valdivia. Inst. de Manajo Forestal.
For primary bibliographic entry see Field 4C.
W91-04118

ANALYTICALLY DERIVED RUNOFF MODELS BASED ON RAINFALL POINT PROCESSES.
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. F. P. Bierkens, and C. E. Puente.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2653-2659, November 1990. 4 fig, 1 tab, 19 ref, append. California Water Resources Center grant W-731.

Descriptors: *Hydrologic models, *Mathematical models, *Model studies, *Rainfall-runoff relationships, *Stochastic models, Computer programs, Data interpretation, Flood rating, Mathematical analysis, Rainfall, Runoff, Stochastic hydrology, Surface runoff, Theoretical analysis.

Several models that try to describe hydrologic processes typically depend heavily on the scale of temporal and spatial aggregation of the available hydrologic data. A simple and realistic rainfall-runoff model was developed whose consistency, when used at different aggregation lengths, could be readily tested. Four stochastic and lumped in space rainfall-runoff models were used, created by combining two stochastic rainfall models with two conceptualizations of a basin's response. Rainfall was given by rectangular pulses whose arrivals were described by Poisson and Neyman-Scott models. Runoff was obtained routing such pulses via two alternative conceptualizations, both based on simple linear reservoirs. General expressions for the first-order and second-order moments were given for both the instantaneous and locally averaged processes. The mathematical structure of the alternative parameterizations was illustrated via computer simulations. Efforts to link to the rainfall models more complex runoff parameterizations, such as the Nash cascade, failed due to the presence of incomplete gamma functions, which then had to be integrated at least twice. The same problem arose when the infiltration rate or the rate of initial losses was taken to be exponential functions instead of constants. Even though the path of computations was well defined, these results illustrated the paradigm that complexity may indeed be obtained from simple rules, and changing the model structure slightly requires basically starting the calculations all over. (Mertz-PTT)
W91-04120

APPROXIMATION FOR THE BANK STORAGE EFFECT.
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
B. Hunt.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2769-2775, November 1990. 5 fig, 5 ref.

Descriptors: *Kinematic wave theory, *Routing, *Stream banks, *Surface-groundwater relationships, Channel flow, Flood routing, Flooding, Groundwater, Mathematical equations, Mathematical studies, Seepage, Streamflow.

Hydrologist have known for many years that the seepage of water through river banks can, under some conditions, significantly modify flood hydrographs. However, quantitative analyses of this problem have not been numerous because of the difficulty in obtaining the simultaneous solution of both open channel and groundwater flow equations. A perturbation procedure was used to calculate an approximate flood-routing solution for the coupled groundwater and open channel flow equations. Seepage is initially neglected to calculate the solution of the linearized kinematic wave equations. The kinematic wave solution is then used to obtain a solution for the groundwater problem, and this groundwater solution was used to obtain a second-order solution for the flood-routing problem. The solution had a relatively simple form that was easily applied. An example suggested that changes created in the downstream hydrograph by bank storage could be of the same order as changes created by retaining all terms in the open channel flow equations and routing the flood down the channel with zero bank storage. (Mertz-PTT)
W91-04130

INSTREAM FLOW ANALYSIS AND MONITORING PROCEDURE FOR LITTLE RIVER IN EASTERN TENNESSEE.
Geological Survey, Memphis, TN. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04169

DROUGHT DURATION AND FREQUENCY IN THE NORTH-CENTRAL GREAT BASIN, 1600-1982, AND IMPLICATIONS FOR WATER SUPPLY.
Geological Survey, Carson City, NV. Water Resources Div.
W. D. Nichols.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 479-485, 6 fig, 1 tab, 8 ref.

Descriptors: *Drought, *Drought effects, *Water resources management, *Water supply, *Water use data, Dendrochronology, History, Water conservation, Water deficit.

Drought duration and frequency are important factors in the design and operation of surface water supply systems. Under-designed systems may lead to water shortages and disruptive water conservation measures. Over-designed facilities lead to unnecessary construction costs. Fifty years of drought history in the north-central Great Basin, based on the July Palmer Drought Severity Index (JPDSI) indicate that droughts had a mean duration of about two years and a mean frequency of about three years. Of the 19 drought years that occurred from 1932-1981, 4 occurred during 2 year droughts, 4 occurred during one 4 year drought, and 5 occurred during a 5 year drought; this accounts for 13 of the 19 years. The drought recurrence interval is complicated by a 9 year period from 1941 to 1949 during which no drought occurred. The question arises as to whether 50 years of record are sufficient to define satisfactory drought duration and frequency statistics. A reconstructed drought history for the same area, based on JPDSI derived from a 383 year tree-ring chronology, provides a longer time series to examine drought duration and frequency. The calculated JPDSI indicated that 100 drought years have occurred between 1601 and 1982. Of these, 32 were 1 year droughts and 32 occurred as 2 year droughts. The calculated mean duration of drought is about 2 years. The mean interval between droughts is about 5 years, but there were non-drought periods of 16, 18, and 24 years. Given specific applications, the statistics derived from the reconstructed drought record can assist in the development of deigns and operating criteria for water supply systems. The longer time series provided by the reconstructed drought record may provide additional confidence in the derived statistics. (See also W91-04161) (Author's abstract)
W91-04212

USE OF BASE-FLOW DATA TO MANAGE WATER USE DURING A DROUGHT.
Geological Survey, Oklahoma City, OK. Water Resources Div.
R. L. Hanson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 487-498, 8 fig, 1 tab, 8 ref.

Descriptors: *Base flow, *Drought effects, *Water resources management, *Water use, *Water use data, Blue River, Case studies, Drought, Oklahoma, Seasonal variation, Water demand, Water supply.

Droughts are generally slow in developing, frequently occur for a long time, and can affect a large area. When regional water supplies decrease to less than the long-term average, a potential hydrologic drought may exist. The severity of a hydrologic drought is not always apparent until the depleted water supplies fail to meet the water use requirements for the region. A study used the seasonal base flow characteristics of the Blue River, a 203 sq mi unregulated water shed in south-central Oklahoma, to illustrate how streamflow availability can be evaluated during a hydrologic drought. Base flow is selected from historic streamflow hydrographs and is used to define the frequency of occurrence of base flow for each month during January through September. Base flow recession curves are defined for this 9 month period and are used to project assured base flow from the winter season through the subsequent spring and summer months. The magnitude of monthly increases in base flow is also evaluated to describe the probability that the projected assured base flow will be exceeded. These base flow relations can be used by water managers to make projections of streamflow availability when a prolonged hydrologic drought is anticipated or is occurring. (See also W91-04161) (Author's abstract)
W91-04213

WATER CONSERVATION FOR DROUGHT MANAGEMENT.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3B.
W91-04214

CLIMATE CHANGE AND CHANGES IN CALIFORNIA SNOWMELT-RUNOFF PATTERNS.
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.
For primary bibliographic entry see Field 2B.
W91-04215

GROUND WATER, GEOMORPHIC PROCESSES, AND RIPARIAN VALUES: SAN PEDRO RIVER, ARIZONA.
Bureau of Land Management, Phoenix, AZ. Arizona State Office.
For primary bibliographic entry see Field 6G.
W91-04218

ANALYSIS OF OBJECTIVE FUNCTIONS USED IN URBAN RUNOFF MODELS.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
A. R. Rao, and J. Han.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 743-757, 9 tab, 19 ref.

Descriptors: *Data interpretation, *Model studies, *Urban hydrology, *Urban runoff, *Water use

data, Flood peak, Flow profiles, Hydrographs, Hydrologic models, Rainfall-runoff relationships.

An index of agreement between observed and calculated hydrographs is needed in order to estimate the parameters of urban rainfall-runoff models. This index is usually called the objective function. The selection of objective functions, to a certain extent, depends on the problem. For example, for the design of detention storage facilities, the objective function must emphasize the total runoff volume under the hydrograph. For the problem of sizing drainage system pipes, it is better to define an objective function which emphasizes the peak flows and the shape of design hydrographs. The objective functions used in parameter estimation in urban runoff models are determined by using the urban runoff model ILLUDAS. Two sets of objective mathematical functions are used along with rainfall runoff data from urban watersheds in the United States. The results indicate that the last squares criterion is the best among those studied. (See also W91-04161) (Author's abstract)
W91-04239

NEW NUMERICAL/PHYSICAL FRAMEWORK FOR MOBILE-BED MODELLING, PART I: NUMERICAL AND PHYSICAL PRINCIPLES.
Iowa Univ., Iowa City.
For primary bibliographic entry see Field 2J.
W91-04303

URBAN STORM-INDUCED DISCHARGE IMPACTS: US ENVIRONMENTAL PROTECTION AGENCY RESEARCH PROGRAM REVIEW.
Environmental Protection Agency, Edison, NJ. Storm and Combined Sewer Technology Branch.
For primary bibliographic entry see Field 5C.
W91-04322

COMBINED LONG-TERM SIMULATION OF RUNOFF FROM URBAN AND RURAL AREAS.
Addis Ababa Univ. (Ethiopia). Faculty of Technology.
For primary bibliographic entry see Field 5B.
W91-04333

COINCIDENT PROBABILITY OF GIVEN STORM WATER DISCHARGES IN URBAN SEWER SYSTEMS AND RECEIVING WATERS.
Kaiserslautern Univ. (Germany, F.R.). Fachgebiet Wasserbau und Wasserwirtschaft.
J. Sartor.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 267-270, 1990. 4 fig, 4 ref.

Descriptors: *Flow characteristics, *Model studies, *Pollution load, *Runoff forecasting, *Sewer systems, *Storm runoff, *Storm water, *Urban hydrology, *Urban runoff, Combined sewer overflows, Flood peak, Flow discharge, Hydrographs, Hydrologic models, Probability distribution, Simulation analysis, Soil water, Water pollution effects, Water quality, Water stress.

In the field of pollution load modeling the knowledge of how active rain overflows from urban sewer systems coincide with peak discharges in receiving waters is essential. Often questions are raised concerning the probability of the simultaneous occurrence of given discharges in sewers and rivers, because both hydrographs have to be superimposed to determine qualitative and quantitative effects upon the receiving water. These might consist of hydraulic problems and stresses by pollution loads. Also, the design of corrective measures, such as overflow structures and retention facilities, must consider the coincident probability of both flood events. The relative period-of-record simulation method is applicable for dependent and independent events, and allows for the transfer of its relative results to similar hydrological conditions. A real case was studied using this procedure. Because of the lack of a streamgage, a hydrological storm runoff model was adopted for the entire system, wherein the parameters for the urban sewer system had been calibrated by a dynamic flow routing model. From 21 years of raingage records, 133 storm events were selected and simulated with their real hydrographs. Special emphasis was placed upon the antecedent soil moisture conditions. The resulting flow hydrographs from the receiving stream and from the sewer system were separately statistically analyzed. The coincident probability shows good correlation, because of the strong influence of the drained areas, even if their absolute flow values differ considerably. It was concluded that the watershed characteristics affect the degree of dependence. (Fish-PTT)
W91-04354

ANALYTICAL REPRESENTATION OF CROSS-SECTION HYDRAULIC PROPERTIES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
J. Garbrecht.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 43-56, November 1990. 8 fig, 3 tab, 7 ref.

Descriptors: *Channel flow, *Channel morphology, *Hydraulic geometry, *Hydraulic properties, *Routing, *Streamflow forecasting, Little Washita River, Mathematical models, Oklahoma, Open-channel flow.

Hydraulic properties (HPs) of channel cross-section are required for numerical channel flow routing. HPs of interest generally are cross-sectional area, wetted perimeter (or top width), and conveyance factor. An alternative power function representation of HPs for one-dimensional flow routing in channels with compound cross sections is proposed. The independent variable is flow depth. The alternative power function representation is continuous with flow depth and it follows the trend of suddenly changing HP values at overbank elevation. It is applicable to a large range of complex section shapes, which may include overbank channels, natural levees, and minor channel irregularities such as sand bars and small terraces where simple power functions have failed. The alternative power function representation is simple and highly efficient from the computational point of view. Efficiency and extended capabilities make it an attractive procedure for one-dimensional channel flow routing in drainage networks where hydraulic properties of many cross-sections need repeated evaluation. Its performance is illustrated for several actual compound cross-sections (Little Washita River, Oklahoma). (Author's abstract)
W91-04389

RELATIONSHIPS IN REGIONAL GROUNDWATER DISCHARGE TO STREAMS: AN ANALYSIS BY NUMERICAL SIMULATION.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2A.
W91-04400

HILLSLOPE PARAMETER ESTIMATION USING THE INVERSE PROCEDURE.
Western Australia Univ., Nedlands. Dept. of Civil Engineering.
R. H. B. Hebbert, and R. E. Smith.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 307-334, November 1990. 16 fig, 3 tab, 18 ref.

Descriptors: *Australia, *Catchment areas, *Hydrologic properties, *Model studies, *Rainfall-runoff relationships, *Runoff, *Slopes, *Soil properties, Evaporation, HILLS model, Hydraulic conductivity, Mathematical models, Numerical analysis, Porosity, Storm runoff, Surface-groundwater relations.

The parameter identification process referred to as the 'inverse' method was applied at the hillslope scale to quantify the hydrologic characteristics of two catchments in Western Australia. The physically-based numerical model HILLS was used. Despite the limitations imposed by using a model that contains several simplifying assumptions, in contrast to the high level of complexity within the soil profile, an encouraging level of representation is achieved. It also has been shown that water-level data from shallow wells provide a promising method for determination of the average or 'effective' values of vertical and horizontal hydraulic conductivity, soil porosity, and rates of evaporation. The model also provides an estimate of the various sources of stormflow, surface, subsurface, and groundwater, which occurs during and after a rainstorm. (Author's abstract)
W91-04405

FINITE ELEMENT SIMULATION OF NONLINEAR KINEMATIC SURFACE RUNOFF.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
G. E. Blandford, and M. E. Meadows.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 335-356, November 1990. 12 fig, 2 tab, 18 ref, append.

Descriptors: *Finite element method, *Kinematic wave theory, *Model studies, *Rainfall-runoff relationships, *Runoff, *Runoff forecasting, *Simulation, Algorithms, Comparison studies, Discretization, Mathematical equations, Mathematical models, Performance evaluation.

Formulation details and sample simulation results are presented for the microcomputer program Finite Element Kinematic Wave Program (FEKWP). FEKWP uses an implicit finite element formulation of the nonlinear kinematic wave approximation for routing surface runoff. Resistance to flow is described by a generalized flow resistance equation that includes laminar, turbulent, and transitional flow representations or by a uniform flow resistance approximation. Linear, quadratic, and/or cubic one-dimensional Lagrangian finite elements are used for the spatial discretization of the kinematic wave approximation. Temporal discretization of the finite element equations is based on an implicit linear time interpolation algorithm. The implicit finite element discretization leads to a system of nonlinear algebraic equations. Solution of the nonlinear equations is obtained using an explicit finite difference algorithm to predict the solution followed by an iterative strategy to correct the solution. A method was developed to estimate a suitable computation time-step size based on the Courant condition. Kinematic surface runoff simulation results were obtained for two problems involving laminar flow and a third problem involving laminar, mixed, and turbulent flow. The finite element simulations compare favorably with observed experimental data and previously published results. (Rochester-PTT)
W91-04406

RELIABILITY BASED TIME AXES FOR FLOOD DATA PRESENTATION.
Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences.
W. E. Bardsley.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 389-391, November 1990. 1 fig, 3 ref.

Descriptors: *Data collections, *Design criteria, *Flood forecasting, *Flood frequency, *New Zealand, Extreme events, Flood peak, Mathematical equations, Return period, Waipoa River.

It is standard for a major structure in a river environment to have some predetermined N-year operational lifetime. It is well known that designing against the N-year return period flood magnitude is not consistent with a high reliability for an N-year lifetime. Specifically, designing against the N-year event will generate a reliability not exceeding R = 0.37 (assuming stationarity). Apart from the obvious practical problem of extrapolation, the use of long return periods in design work raises questions of both validity and perception. There is no obvious way to avoid the problems of extrapolation in designing against extreme events, but the other aspects could be considerably improved by the adoption of time axes based on reliability rather than return periods. That is, a time axis is constructed based on some specified reliability R. Reading up the graph from N years on this axis will yield an estimate of the discharge magnitude that has a probability R of non-exceedance in N years. Regardless of the value or R, there is no necessity to extend the time scale beyond the intended operational lifetime of the structure concerned. The graph employed uses discharge as the

vertical axis and a horizontal base scale defined as $Y = \ln(-\ln(F(x)))$, where Y is an increasing function U of F(x), and F(x) is the distribution function of the annual flood maxima. Use of this method for the Waipoa River near Gisborne, New Zealand, is presented. (Rochester-PTT)
W91-04408

DAY-TO-DAY VARIABILITY IN THE PLANKTON COMMUNITY OF A COASTAL SHALLOW EMBAYMENT IN RESPONSE TO CHANGES IN RIVER RUNOFF AND WATER TURBULENCE.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
For primary bibliographic entry see Field 2L.
W91-04412

OPTIMIZATION OF INSECTICIDE TREATMENTS IN RIVERS: AN APPLICATION OF GRAPH THEORY FOR PLANNING A BLACK FLY LARVAE CONTROL PROGRAM.
Quebec Univ., Trois-Rivieres. Groupe de Recherche sur les Insectes.
For primary bibliographic entry see Field 4C.
W91-04446

DIRECT AND INDIRECT EFFECTS OF CONSUMERS ON BENTHIC ALGAE IN ISOLATED POOLS OF AN EPHEMERAL STREAM.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
P. V. McCormick.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 2057-2065, October 1990. 7 fig, 1 tab, 38 ref.

Descriptors: *Algal growth, *Aquatic animals, *Ecosystems, *Ephemeral streams, *Food chains, *Limiting nutrients, *Streams, Biomass, Crayfish, Herbivory, Predation, Snails, Survival.

Artificial pools were used to test for interactions among dominant consumer and producer populations that coexist in isolated pools of an ephemeral stream each summer. Nitrogen and/or phosphorus were supplied to one set of pools; herbivorous snails and crayfish and a predaceous centrarchid were added in different combinations to other pools. Algal growth was measured inside and outside wire cages placed in pools to exclude herbivores and/or predators. Algal biomass and the abundance of most algal species were increased by nitrogen enrichment. Algal biomass was also enhanced by addition of consumers. Few differences in structure existed between algal assemblages inside and outside cages in any treatment. Under conditions of nitrogen limitation, moderate levels of herbivory can enhance algal growth. Positive effects are greatest at the microsite level and may depend on the ability of algal species to resist digestion by grazers. Predators may affect the algal assemblage indirectly by reducing herbivore survival or activity and directly by converting nutrients stored in herbivore biomass into a form available for algal growth. Because the importance of different trophic connections may vary among ecosystems, experimentation must consider all those that are potentially important. (Author's abstract)
W91-04447

CONCEPT OF THE SHALLOW GROUNDWATER SYSTEM ALONG THE NORTH PLATTE RIVER, SOUTH-CENTRAL WYOMING.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04463

EFFECTS OF URBANIZATION ON PEAK STREAMFLOWS IN FOUR CONNECTICUT COMMUNITIES, 1980-84.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 4C.
W91-04464

FLOW CHARACTERISTICS OF STREAMS THAT DRAIN THE FORT APACHE AND SAN CARLOS INDIAN RESERVATIONS, EAST-CENTRAL ARIZONA, 1930-86.
Geological Survey, Tucson, AZ. Water Resources Div.
S. Baldys, and J. A. Bayles.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4053, 1990. 59p, 5 fig, 1 pl, 3 tab, 37 ref. Project No. AZ112.

Descriptors: *Arizona, *Streamflow, *Surface water, *Water resources data, Fort Apache Indian Reservation, San Carlos Indian Reservation, Statistics, Water supply.

Streamflow characteristics of the Salt River and Gila River basins in the Fort Apache and San Carlos Indian Reservations, were studied in response to pending adjudication of water resources in those basins. Statistical summaries were compiled for 28 streamflow-gaging stations in and near the reservation. Mean annual streamflow for 1930-86 was computed for stations with complete records for the period; for those stations with records that did not completely cover the 1930-86 period, record extension techniques were used. Mean annual streamflow for ungaged sites on streams with gaging stations was estimated by interpolation between data points using drainage-area ratios. Two regional-regression equations were derived to estimate mean annual streamflow at sites on ungaged natural streams. The standard error of the regression for estimation of mean annual flow for sites in the Salt River basin is -37 to +59%. The standard error of the regression for estimation of mean annual flow for sites in the Gila River basins is -18 to +21%. (USGS)
W91-04469

BASE-FLOW INVESTIGATION ON THE SACRAMENTO RIVER, SEPTEMBER 25, 1985, NEAR SUNSPOT, OTERO COUNTY, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04475

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1989.
Geological Survey, Bow, NH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04480

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1989.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04481

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989, VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04482

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1989.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04483

EFFECTS OF ENVIRONMENTAL FACTORS ON JUMPING BEHAVIOUR OF THE JUVENILE AYU PLECOGLOSSUS ALTIVELIS WITH SPECIAL REFERENCE TO THEIR UPSTREAM MIGRATION.
Tokyo Univ. (Japan). Ocean Research Inst.
For primary bibliographic entry see Field 8I.
W91-04526

EFFECT OF PARENTAL ORIGIN ON JUMPING AND SPACING BEHAVIOURS OF JUVENILE AYU PLECOGLOSSUS ALTIVELIS WITH SPECIAL REFERENCE TO THEIR UPSTREAM MIGRATION.
Tokyo Univ. (Japan). Ocean Research Inst.
For primary bibliographic entry see Field 8I.
W91-04527

DO ORGANIC AND ANTHROPOGENIC ACIDITY HAVE SIMILAR EFFECTS ON AQUATIC FAUNA.
Canterbury Univ., Christchurch (New Zealand). School of Forestry.
For primary bibliographic entry see Field 5C.
W91-04528

ANNUAL PRODUCTION AND PRODUCTION: BIOMASS RATIOS FOR THREE SPECIES OF STREAM TROUT IN LAKE SUPERIOR TRIBUTARIES.
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W91-04589

STREAMFLOW CHARACTERISTICS OF SMALL TRIBUTARIES OF ROCK CREEK, MILK RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1983-1987.
Geological Survey, Helena, MT.
C. Parrett, and J. A. Hull.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water Investigations Report 89-4206, 1990. 10p, 1 fig, 3 tab, 2 ref. Prepared in cooperation with the U.S. Bureau of Land Management.

Descriptors: *Milk River, *Montana, *Rock Creek, *Streamflow, Annual runoff, Flow measurement, Runoff, Tributaries.

Five streamflow gaging stations--four on small tributary streams and one on Rock Creek--were installed in the Rock Creek basin north of these gaging stations and at an existing gaging station upstream on Rock Creek, from May 1983 through September 1987. On the basis of 9 years of record at the existing gaging station, annual mean streamflow in the study area was substantially less than the long-term (1979-87) mean annual streamflow (17 cu ft/sec) during water years 1983-85, and was greater than the mean annual streamflow during water years 1986-87. Annual mean streamflow for 1983-87 ranged from 2.8 to 57 cu ft/sec in the mainstem and from zero to 0.06 cu ft/sec in the tributaries. Monthly mean streamflow at the six gaged sites ranged from zero to 528 cu ft/sec. Although monthly runoff trends of the four tributary streams were similar to those of Rock Creek, monthly mean flows of the four tributary streams were small, ranging from zero to 5.3 cu ft/sec. Daily mean streamflow data for the six gaged sites indicate similar patterns during periods of large runoff, but substantial individual variations during periods of lesser runoff. During periods of little area-wide runoff, the small streams may have daily mean flow that is several times larger than that at the two Rock Creek sites. Daily mean streamflows of Rock Creek were often less at the downstream site than at the upstream site. Thus, daily mean streamflow in the tributaries appears to be closely related to daily mean streamflow in mainstem Rock Creek only during periods of substantial area-wide runoff. Streamflow in the tributaries resulting from local storms or local snowmelt may not contribute to streamflow in the mainstem. (Author's abstract)
W91-04634

FLOOD OF APRIL 4-5, 1987, IN SOUTHEASTERN NEW YORK STATE, WITH FLOOD PROFILES OF SCHOHARIE CREEK.
Geological Survey, Albany, NY.
T. J. Zembrzuski, and M. L. Evans.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 89-4084, 1989. 43p, 10 fig, 3 tab, 25 ref. Prepared in cooperation with the New York State Department of Transportation.

Descriptors: *Flood damage, *Flood hydrographs, *Flood profiles, *Mohawk River, *New York, *Schoharie Creek, Catskill Mountains, Disasters, Flood peak, Rainfall-runoff relationships, Rainstorms, Reservoir capacity.

Intense rain that fell April 3-5, 1987, in southeastern New York State caused widespread flooding. As much as 9 in of rain fell in watersheds of the Catskill Mountains, where the soils were already saturated, stream discharges were high, and some reservoirs were at or near capacity from snowmelt and previous rainfall. The flood along Schoharie Creek was the third largest since records began in the early 1900's and was exceeded only by the floods of October 1955 and March 1980. Peak discharge of many streams in the study area exceeded the 25-year recurrence interval. A New York State Thruway bridge collapsed into Schoharie Creek, killing 10 motorists. Flood damage to homes, businesses, crops, roadways, and bridges exceeded $65 million. Five counties were declared as major disaster areas and eligible for Federal disaster assistance. This report presents a summary of peak stages and discharges at sites in the affected area, precipitation maps, floodflow hydrographs of seven streams, inflow hydrographs of six reservoirs, and flood profiles along 83 miles of Schoharie Creek from its mouth on the Mohawk River to its headwaters in the Catskill Mountains. (Author's abstract)
W91-04645

STREAM GEOMORPHOLOGY: EFFECTS ON PERIPHYTON STANDING CROP AND PRIMARY PRODUCTION.
New Mexico Univ., Albuquerque. Dept. of Biology.
For primary bibliographic entry see Field 6G.
W91-04714

ALGAL COLONIZATION UNDER FOUR EXPERIMENTALLY-CONTROLLED CURRENT REGIMES IN A HIGH MOUNTAIN STREAM.
Colorado State Univ., Fort Collins. Dept. of Biology.
N. L. Poff, N. J. Voelz, and J. V. Ward.
Journal of the North American Benthological Society JNASEC, Vol. 9, No. 4, p 303-318, December 1990. 9 fig, 4 tab, 47 ref.

Descriptors: *Algal growth, *Colonization, *Diatoms, *Flow velocity, *Streams, Colorado River, Flow pattern, Spatial distribution, Water currents.

Algal colonization and assemblage development were examined on unglazed ceramic tiles in flow-through troughs over a 42-day period (summer 1987) in the regulated upper Colorado River. The unusually constant discharge of the stream, coupled with the trough design, allowed the establishment and maintenance of four controlled current regimes that differed with respect to range of free-stream velocity and associated near-substratum hydraulic conditions: (1) depositional (free-stream current velocity < 1 cm/sec); (2) slow and hydraulically-smooth (range 14-20 cm/sec); (3) fast and hydraulically-smooth (range 36-47 cm/sec); and (4) fast and hydraulically-rough or turbulently mixed (range 15-46 cm/sec). Biomass was on average 30-40 times higher in the two slow velocity treatments than in the two fast velocity treatments. Chlorophytes, bacillariophytes, and cyanophytes exhibited distinctly different successional trajectories and end-points in all treatments. Ulothrix zonata, established by day 4, was the dominant alga at all velocities for the first two weeks, after which it was replaced by a more diverse assemblage of chlorophytes, except in the Fast-rough regime. Diatoms were common in all treatments, but were only numerically dominant during the latter part of the study. Cyanophytes dominated only in the two lowest current regimes and only at the end of the study. Scanning electron microscopy revealed that physiognomy of algal assemblages also varied across current regimes. The two low velocity treatments were characterized by dense, upright filaments within one week, while three-dimensional assemblage structure in the two high velocity treatments did not develop over the 42-day period. Differences in species composition, successional trajectories and physiognomy across treatments demonstrated that current regime (free-stream velocity and pattern of flow) was an important determinant of algal assemblage structure in the absence of hydrologic and grazing disturbances. (Author's abstract)
W91-04715

SMALL FLUME FOR STUDYING THE INFLUENCE OF HYDRODYNAMIC FACTORS ON BENTHIC INVERTEBRATE BEHAVIOR.
Alberta Univ., Edmonton. Dept. of Entomology.
J. O. Lacoursiere, and D. A. Craig.
Journal of the North American Benthological Society JNASEC, Vol. 9, No. 4, p 358-367, December 1990. 6 fig, 29 ref.

Descriptors: *Benthos, *Flumes, *Invertebrates, *Streams, Flow pattern, Flow velocity, Hydraulic machinery, Hydrodynamics.

A compact, versatile flume for studying the influence of hydrodynamic factors on the behavior of benthic invertebrates is described. A range of lotic micro-environments can be simulated under controlled and replicable conditions by tailoring the velocity profile at the entrance of the test section. A specially designed diffuser composed of an array of adjustable horizontal rods allows tailored flow (e.g., zone of high shear stress, adjustable velocity gradient and turbulence level) to which organisms can be exposed. Water velocities of up to a maximum of 81.5 + or -0.6 cm/sec, with a turbulence intensity of 0.8% can be achieved. Simultaneous observations of flow and organism behaviors can be done by means of standard flow visualization techniques. Compact (72 cm long by 22 cm high by 10 cm wide; volume 10 L) and easily transportable, this flume is an inexpensive compact version of larger, more bulky systems, without sacrifice of performance and versatility. (Author's abstract)
W91-04716

DOWNSTREAM EFFECTS OF A SMALL IMPOUNDMENT ON A TURBID RIVER.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
For primary bibliographic entry see Field 6G.
W91-04740

HABITAT ALTERATION AND ITS EFFECTS ON NATIVE FISHES IN THE UPPER TENNESSEE RIVER SYSTEM, EAST-CENTRAL U.S.A.
Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg.
For primary bibliographic entry see Field 6G.
W91-04783

FISH OF THE AMAZONIAN IGAPO: STABILITY AND CONSERVATION IN A HIGH DIVERSITY-LOW BIOMASS SYSTEM.
Central Electricity Generating Board, Fawley (England). Marine Biological Unit.
For primary bibliographic entry see Field 2H.
W91-04784

RARE FISHES OF HIMALAYAN WATERS OF NEPAL.
Tribhuvan Univ., Kathmandu (Nepal). Dept. of Zoology.
For primary bibliographic entry see Field 8I.
W91-04792

VALUES OF LOWLAND RIVERS FOR THE CONSERVATION OF RARE FISH IN FLANDERS.
Antwerp Univ., Wilrijk (Belgium). Dept. of Biology.
For primary bibliographic entry see Field 8I.
W91-04793

MAPS OF FLOOD STATISTICS FOR REGIONAL FLOOD FREQUENCY ANALYSIS IN NEW ZEALAND.
Department of Scientific and Industrial Research, Christchurch (New Zealand). Hydrology Centre.
A. I. McKerchar, and C. P. Pearson.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 609-621, December 1990. fig, 1 tab, 20 ref.

Descriptors: *Flood forecasting, *Flood frequency analysis, *Flood maps, *Hydrographic data, *Mapping, *Maps, *New Zealand, *Regional analysis, Flood frequency, Flood hydrographs, Floods, Frequency analysis, Statistical analysis.

The EV1 (extreme value type 1 or Gumble) distribution adequately describes New Zealand at-site flood frequency distributions, usually on an annual basis, but also for biennial or longer time intervals when the annual series includes years without floods. An asset of this distribution is its simplicity and the uncomplicated and uncontroversial manner in which extrapolations to high return period floods can be made. The choice of which statistical distribution to use for flood frequency dominates the literature, when the more difficult and critical question is how to estimate mean annual flood for sites with little or no data. From this study, maps had been developed which are based directly on measured discharge series from a large sample of river recording stations. Thus, when basins are ungauged, or have just a short record, an estimate of flow quantiles can be obtained from the maps without having first to estimate mean annual rainfall, or mean rainfall intensity of the basin, which is particularly difficult in sparsely instrumented mountainous areas. These maps provide a simple summary of much information, and the basis of flood estimation which improves on the previous regional method. (Mertz-PTT)
W91-04802

RIVER FLOW FORECASTING SYSTEM WITH DATA MANAGEMENT, GRAPHICAL RIVER NETWORK CONTROL AND INTERACTIVE OPERATION.
Uppsala Univ. (Sweden). Dept. of Hydrology.
L. Iritz.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 637-651, December 1990. 8 fig, 11 ref.

Descriptors: *Automation, *Computer programs, *Flow models, *Forecasting, *Hydrographic data, *Model studies, *River forecasting, *Streamflow forecasting, Computers, Hydrologic data collections, Hydrometeorology, River flow, Rivers, Sweden, Vasterdalvern River.

The feasibility and success of a forecasting system depend on many factors. Although the models may be of the highest accuracy, they cannot make a forecasting system effective without a well organized database and interpretable output. The interaction between the processes of data management, computation and output presentation should be dynamic. A complete river forecasting system for IBM (or compatible) personal computers aimed at meeting the above demands has been developed at the Department of Hydrology of Uppsala University. The program package sets up the river network, stores a database for it, supplies the appropriate data for a wide choice of forecasting models, and gives interpretable output. The functions are supported by screen graphics. The program, PROGSYS, has available options that during computation may be selected interactively. The models included in PROGSYS are operation oriented. Their parameters, estimated either internally or off-line, show rapid convergence. The parameters estimated off-line are stable and do not need updating too often. Computations on the Vasterdalvern

River, Sweden show that one-day-ahead forecasts can be safely issued between stations. Longer (two or three day) lead time needs an increase in the number of input/upstream stations. (Mertz-PTT)
W91-04804

TRANSPORT OF SUSPENDED SEDIMENT AND DISSOLVED MATERIAL FROM THE ANDES TO THE RIO DE LA PLATA BY THE BOLIVIAN TRIBUTARIES OF THE RIO PARAGUAY (RIOS PILCOMAYO AND BERMEJO), (TRANSPORT DE MATIERES DISSOUTES ET PARTICULAIRES DES ANDES VERS LE RIO DE LA PLATA PAR LES TRIBUTAIRES BOLIVIENS (RIOS PILCOMAYO ET BERMEJO) DE RIO PARAGUAY).
Office de la Recherche Scientifique et Technique Outre-Mer, La Paz (Bolivia).
For primary bibliographic entry see Field 2J.
W91-04805

STRUCTURE OF EPILITHON IN SOME ACIDIC AND CIRCUMNEUTRAL STREAMS IN SOUTH WESTLAND, NEW ZEALAND.
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W91-04812

BACTERIAL HETEROTROPHIC ACTIVITY IN THE RIVER SEINE: TRITIATED THYMIDINE AND LEUCINE INCORPORATION PROFILES (ACTIVITE BACTERIENNE HETEROTROPHE DANS LA SEINE: PROFILS D'INCORPORATION DE THYMIDINE ET DE LEUCINE TRITIEES).
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
For primary bibliographic entry see Field 5C.
W91-04837

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1988.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04868

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1989.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04869

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1989.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04877

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1989, VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04878

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1989. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04903

WATER RESOURCES DATA ARIZONA, WATER YEAR 1989.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W91-04904

MARGINAL ECONOMIC VALUE OF STREAMFLOW: A CASE STUDY FOR THE COLORADO RIVER BASIN.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 6D.
W91-04913

ISOTOPIC EVOLUTION OF RIVER WATER IN THE NORTHERN CHILE REGION.
Waterloo Centre for Groundwater Research (Ontario).
For primary bibliographic entry see Field 2K.
W91-04917

APPROXIMATE ANALYTICAL SOLUTIONS FOR OVERLAND FLOWS.
California Univ., Davis. Dept. of Civil Engineering.
R. S. Govindaraju, M. L. Kavvas, and S. E. Jones.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2903-2912, December 1990. 11 fig, 1 tab, 12 ref. NSF Grant CES-8596023, USDI Grant G-908-03(A-098-KY).

Descriptors: *Hydrologic studies, *Kinematic wave theory, *Model studies, *Overland flow, *Rainfall distribution, *Rainfall-runoff relationships, *Runoff forecasting, Differential equations, Diffusion, Flow discharge, Hydrographs, St Venant equation.

Approximate analytical solutions to the diffusion and kinematic wave models subject to space and time varying rainfall, in the form of the first term of an infinite sine series, have been derived. The shallow water equations govern flows on overland sections, and are comprised of a continuity equation and a momentum equation. These convert the partial differential equation to an ordinary differential equation, and analytical solutions for both rising and recession phases of the hydrograph can be achieved. Time variation in rainfall is important because replacing rainfall with an 'equivalent' constant value can lead to erroneous results. Comparisons with full Saint-Venant solutions, the kinematic wave approximation and experimental results validate the present solution methodology. The one-term analytical solution is shown to perform well in some cases of physical interest. The analytical solution is useful for estimating runoff from steep overland flow sections. (Author's abstract)
W91-04919

HYDROLOGIC FLOW PATH DEFINITION AND PARTITIONING OF SPRING MELTWATER.
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
For primary bibliographic entry see Field 5B.
W91-04925

MECHANISMS AFFECTING STREAMFLOW AND STREAM WATER QUALITY: AN APPROACH VIA STABLE ISOTOPE, HYDROGEOCHEMICAL, AND TIME SERIES ANALYSIS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
J. V. Turner, and D. K. Macpherson.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3005-3019, December 1990. 16 fig, 1 tab, 24 ref.

Descriptors: *Environmental tracers, *Geochemistry, *Isotope studies, *Nutrient transport, *Rainfall-runoff relationships, *Streamflow, *Time series analysis, *Water chemistry, *Water quality, Australia, Chlorides, Deuterium, Groundwater, Nitrates, Water chemistry, Geochemistry.

Stable isotope (deuterium) and hydrogeochemical (chloride, nitrate) data in rainfall, streamflow and deep and shallow groundwaters have been applied to develop an understanding of the mechanisms of streamflow generation and nutrient discharge from a 27 sq. km rural catchment near Perth, Western Australia. Intensive sampling of the stable isotopic composition of rainfall, groundwater and streamflow during the winter flow periods of 1987 and 1988 identified several significant rainfall events that were up to 90 ppt depleted in deuterium relative to deep and shallow groundwaters in the catchment. Isotopic responses in streamflow to the depleted rainfall could be discerned on three time scales: (1) the rainfall events; (2) isotopic relaxation periods lasting up to six weeks as streamflow delta values slowly returned to pre-event values; and (3) a longer seasonal scale response of 2 to 3 months caused by a seasonal isotopic trend in rainfall composition and an increase in the proportion of groundwater in streamflow. The sharp isotopic responses in streamflow were in marked contrast to the attenuated responses observed on a catchment under native forest in the same region. Kalman filtering techniques were applied to the numerical functions linking rainfall amount and streamflow volume and their respective stable isotopic compositions. The average lag between rainfall and streamflow was estimated to quantify the time scales of streamflow generation. Integration of the isotopic, hydrogeochemical and numerical analysis presents a consistent view that surface and subsurface storm flow are important streamflow generating mechanisms over the time scale of a rainfall event. Postevent periods of isotopic relaxation in streamflow are due to discharge of groundwater to streamflow from an ephemeral perched aquifer. (Author's abstract)
W91-04929

HYDROGEOCHEMICAL RESPONSE OF A FORESTED WATERSHED TO STORMS: EFFECTS OF PREFERENTIAL FLOW ALONG SHALLOW AND DEEP PATHWAYS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
P. J. Mulholland, G. V. Wilson, and P. M. Jardine.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3021-3036, December 1990. 11 fig, 4 tab, 62 ref. US Dept. of Energy DE-AC05-840R21400.

Descriptors: *Flow pattern, *Forest hydrology, *Forest watersheds, *Geochemistry, *Rainfall-runoff relationships, *Solute transport, *Storm runoff, *Tennessee, *Water chemistry, Alkalinity, Antecedent moisture, Nutrients, Saturation zone, Trace metals, Water chemistry, Geochemistry.

Hydrology and solute chemistry were monitored during four storms in a forested watershed in karst terrain in eastern Tennessee at spatial scales ranging from a 0.5 ha upper hillslope subcatchment to a 38.4 ha watershed drained by a first-order stream. Storm flow was generated from large portions of the watershed as a result of subsurface preferential flow initiated by zones of perched saturation in the soil profile. For most storms, runoff per unit area increased with increasing catchment size, indicating that preferential flow was primarily vertical along relatively deep pathways that emerged in the lower portions of the watershed. However, when antecedent soil moisture was high and rainfall was large, runoff was similar across catchment sizes, indicating that preferential flow was largely lateral along shallow paths (< 2.5 m deep). Concentrations of some solutes differed for shallow and deep flow paths because dominant sources and sinks are stratified vertically in the watershed. Runoff generated by preferential flow along shallow flow paths resulted in higher exports of chlorine, aluminum, sulfate, and dissolved organic carbon and lower exports of alkalinity, calcium, magnesium, and soluble reactive phosphorus than an equivalent amount of runoff generated by preferential flow via deeper flow paths. (Author's abstract)
W91-04930

STREAMFLOW GENERATION PROCESSES: AN AUSTRAL VIEW.
Forest Research Inst., Christchurch (New Zealand). Forest and Wildland Ecosystems Div.
A. J. Pearce.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3037-3047, December 1990. 11 fig, 24 ref.

Descriptors: *Australia, *New Zealand, *Rainfall-runoff relationships, *Storm runoff, *Streamflow,

*Surface-groundwater relations, Flow channels, Flow measurement, Hydrography, Mathematical models, Vegetation effects.

Studies in different austral physical environments have documented substantial differences in the relative importance of various flow-response mechanisms in generating storm runoff. Some of the global extremes of high, and possibly low, streamflow responsiveness to storm rainfall have also been documented in New Zealand and Australia. The low flows are sustained at a high level by groundwater discharge. Flow responsiveness and flow processes are strongly influenced by rainfall climate but also are influenced by catchment storage. On the smaller catchments, the influences of rainfall climate and of effective water storage in the regolith on streamflow responsiveness to rainfall are still very strong. The influence of vegetative cover on streamflow appears strongest at low or very low flows, and is difficult to detect at high flows. Increasingly detailed studies of small catchments and of hillslope and valley bottom segments have revealed increasingly complex and variable responses both in time and space. Although these studies have greatly increased conceptual understanding of flow generation, there has not yet been a corresponding increase in ability to model or predict flow processes. Further progress will require integration of field studies with chemical, physical and mathematical model studies of specific processes to test hypotheses derived from previous work at well-documented field sites. Concentration of the necessary skills and studies at a few intensively studied locations is also required, but this will impose new and difficult challenges for cooperation among specialists, research organization, and funding sources. (Brunone-PTT)
W91-04931

PREFERENTIAL FLOW AND THE GENERATION OF RUNOFF: 1. BOUNDARY LAYER FLOW THEORY.
Bern Univ. (Switzerland). Geographisches Inst.
P. F. Germann.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3055-3063, December 1990. 2 fig, 2 tab, 45 ref.

Descriptors: *Boundary layers, *Flow models, *Groundwater movement, *Runoff, *Soil water, *Surface-groundwater relations, Capillarity, Hydrodynamics, Infiltration, Mathematical models, Richards equation, Slope effects.

Approaches to soil water flow, which are based on the theory of potential flow, often overestimate either the volume of flow or the response time at the hillslope scale when their results are compared with observations. Macropore flow is frequently thought to be the reason for the discrepancy between observations and model performance. The expression macropore flow is considered to be too restricting, confining the rapid flow and transport processes to the easily observed channels and concealing the more general question as to what degree potential flow theory adequately describes flow in porous media. The application of potential flow theory to infiltration leads to the Richards equations only when hydrodynamic dispersion of soil water and capillary potential are perfectly correlated. A boundary layer infiltration model, based on kinematic theory, is developed and expanded to lateral flow in a sloping soil. The application of boundary layer flow theory to infiltration includes the decoupling of hydrodynamic dispersion of soil moisture from that of capillary potential, leading to the conclusion that not more than 10% of actual soil moisture is directly participating in the flow process. (Author's abstract)
W91-04933

NATURALLY OCCURRING RADON 222 AS A TRACER FOR STREAMFLOW GENERATION: STEADY STATE METHODOLOGY AND FIELD EXAMPLE.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
D. P. Genereux, and H. F. Hemond.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3065-3075, December 1990. 1 fig, 1 tab, 54 ref, 2 append. NIEH contract NIH5P42ES04675-03, US Geological Survey contract 14-08-0001-G1725, NSF contract BCS-8906032.

Descriptors: *Isotopic tracers, *Radon radioisotopes, *Steady flow, *Streamflow, *Surface-groundwater relations, *Tracer studies, Base flow, Flow pattern, Hydrocarbons, Hydrologic models, Mass balance equations, Massachusetts, Mathematical models, Saturation.

A quantitative framework for the use of naturally occurring radon-222 as a hydrologic flow path tracer under conditions of steady streamflow is presented which consists of two distinct parts. The first part determines the average radon-222 content of the water (R) feeding a given stream reach by measuring the concentrations of radon-222 and two injected tracers (one conservative, the other volatile) in the stream water and solving a mass balance equation for radon-222 around the reach of interest. The second part of the methodology involves the use of R values to determine the sources of stream inflow (and, implicitly, the flow paths important in streamflow generation). One means of accomplishing this uses simple 'geographic source' separations. Both parts of the methodology were illustrated with a field experiment at the Bickford watershed in central Massachusetts. The injected tracers were sodium chloride (conservative) and propane (volatile). The value of R (700 disintegrations per minute (dpm)/L) was found to be closer to the radon-222 content of vadose zone (500 dpm/L) than to that of saturated zone water (2000 dpm/L), suggesting that lateral unsaturated flow was important in supplying base flow at the study site. (Author's abstract)
W91-04934

CHEMISTRY OF IRON, ALUMINIUM, AND DISSOLVED ORGANIC MATERIAL IN THREE ACIDIC, METAL-ENRICHED, MOUNTAIN STREAMS, AS CONTROLLED BY WATERSHED AND IN-STREAM PROCESSES.
Geological Survey, Denver, CO.
D. M. McKnight, and K. E. Bencala.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3087-3100, December 1990. 11 fig, 6 tab, 40 ref.

Descriptors: *Acid mine drainage, *Acid streams, *Acidification, *Aluminum, *Dissolved solids, *Iron, *Mountain streams, *Stream chemistry, *Water chemistry, *Watersheds, Chemical precipitation, Hydrogen ion concentration, Organic carbon, Photolysis, Solute transport, Trace metals, Tracer studies, Transport models.

Several studies were conducted in three acidic, mountain streams, and the results provide a synthesis of watershed and in-stream processes controlling iron, aluminum and dissolved organic carbon (DOC) concentrations. One of the streams, the Snake River, is naturally acidic; the other two, Peru Creek and St. Kevin Gulch, receive acid mine drainage. Analysis of stream water chemistry data for the acidic headwaters of the Snake River shows that some trace metal solutes (aluminum, manganese, zinc) are correlated with major ions, indicating that watershed processes control their concentrations. Once in the stream, biogeochemical processes can control transport is they occur over time scales comparable to those for hydrologic transport. In-stream reactions include photoreduction and dissolution of hydrous iron oxides in response to an experimental decrease in stream pH, precipitation of aluminum at three stream confluences, and sorption of dissolved organic material by hydrous iron and aluminum oxides in a stream confluence. The extent of these reactions is evaluated using conservative tracers and a transport model that includes storage in the substream zone. (Author's abstract)
W91-04936

2F. Groundwater

PROTECTING GROUND WATER FROM THE BOTTOM UP: LOCAL RESPONSES TO WELLHEAD PROTECTION.
For primary bibliographic entry see Field 5G.
W91-03921

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
For primary bibliographic entry see Field 5G.
W91-03930

USE OF TIME OF TRAVEL IN ZONE OF CONTRIBUTION DELINEATION AND AQUIFER CONTAMINATION WARNING.
Island Design, New Hartford, CT.
For primary bibliographic entry see Field 5B.
W91-03931

DELINEATION OF CONTRIBUTING AREAS TO PUBLIC SUPPLY WELLS IN STRATIFIED GLACIAL-DRIFT AQUIFERS.
Geological Survey, Marlborough, MA.
For primary bibliographic entry see Field 5G.
W91-03932

GROUND WATER RESOURCE BASED MAPPING, NASHUA REGIONAL PLANNING AREA, NEW HAMPSHIRE.
Environmental Protection Agency, Boston, MA. Region I.
For primary bibliographic entry see Field 6A.
W91-03940

PRIVATE WELL PROTECTION IN SAND AND GRAVEL AQUIFERS.
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 5G.
W91-03943

IMPROVEMENTS IN GROUNDWATER RECHARGE ESTIMATION USING SATELLITE REMOTE SENSING.
University Coll., Cardiff (Wales). Dept. of Civil and Structural Engineering.
For primary bibliographic entry see Field 7B.
W91-03957

CONTINUING IMPORTANCE OF NITRATE CONTAMINATION OF GROUNDWATER AND WELLS IN RURAL AREAS.
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
For primary bibliographic entry see Field 5B.
W91-04003

SETTING HUMAN-HEALTH-BASED GROUNDWATER PROTECTION STANDARDS WHEN TOXICOLOGICAL DATA ARE INADEQUATE.
Natural Resources Defense Council, Inc., New York.
For primary bibliographic entry see Field 5G.
W91-04010

GAME-THEORETIC PARAMETER CONFIGURATION TECHNIQUE FOR AQUIFER RESTORATION DESIGN.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. W. Eheart, M. R. Rahman, S. M. Keith, and A. J. Valocchi.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 205-226, October 1990. 10 fig, 2 tab, 18 ref.

Descriptors: *Aquifer restoration, *Aquifers, *Groundwater pollution, *Mathematical models, *Model studies, *Optimization, *Water pollution treatment, Design criteria, Monte Carlo method, Pumping, Theoretical analysis.

The problem of designing an active hydraulic system for remediation of a polluted aquifer is

addressed for the case when parameters are not known with certainty. The design problem is cast as a game in which the protagonist-designer is pitted against an antagonist which alters the values of the uncertain parameters, within prescribed limits, so as to render the engineered system most ineffective. A solution method for the antagonist's problem, referred to as the parameter configuration technique was developed. This technique selects spatially dependent values of the distributed parameter, transmissivity, such that the pattern of variation represents a pessimistic (but realistic) set of design conditions. The task of finding the worst set of parameter values is cast as a constrained optimization problem whose objective function is to thwart the remedial action design to the greatest degree possible. A rudimentary objective function is arbitrarily specified by the researchers. Several types of feasibility constraints restrict the distribution of parameter values to those combinations that are realistic. One type limits the variogram, another type, the mean, and a third type, the trend, of the log transmissivity. The resulting optimization problem is ill-behaved; difficulty was encountered obtaining a mathematically optimal solution. Two special heuristic techniques for obtaining a near-optimal solution are selective constraint abeyance and reverse formulation. The parameter configuration technique is applied to a hypothetical contaminated aquifer with a simple single-extraction well flushing system. The solution is compared to a Monte Carlo approach applied to the same aquifer. The required pumping rate for a pessimistic parameter set generated by the new technique is about the same as the second largest of 100 Monte Carlo realizations. (Author's abstract)
W91-04028

EXPERIMENTAL STUDY OF NON-UNIFORM FLOW IN GRANULAR POROUS MEDIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 2G.
W91-04029

COLLOID-RELATED INFILTRATION OF TRACE METALS FROM A RIVER TO SHALLOW GROUNDWATER.
Bern Univ. (Switzerland). Radiochemisches Lab.
For primary bibliographic entry see Field 5B.
W91-04031

DESIGN AND APPLICATION OF A CONSTANT HEAD WELL PERMEAMETER FOR SHALLOW HIGH SATURATED HYDRAULIC CONDUCTIVITY SOILS.
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 7B.
W91-04102

RECHARGE PROCESSES DURING SNOWMELT: AN ISOTOPIC AND HYDROMETRIC INVESTIGATION.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
J. M. Buttle, and K. Sami.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 343-360, October/December 1990. 11 fig, 33 ref.

Descriptors: *Groundwater recharge, *Hydrometry, *Infiltration, *Isotope studies, *Recharge, *Snowmelt, Deuterium, Groundwater movement, Interstitial water, Soil water, Unsaturated flow, Vadose zone.

Results from hydrometric and isotopic investigations of unsaturated flow during snowmelt are presented for a hillslope underlain by well-sorted sands. Passage of melt and rainwater through the vadose zone was detected from temporal changes in soil water deuterium concentrations obtained from sequential soil cores. Bypassing flow was indicated during the initial snowmelt phase, but was confined to the near-surface zone. Recharge below this zone was via translatory flow, as meltwater inputs displaced premelt soil water. Estimates of premelt water fluxes indicate that up to 19% of the premelt soil water may have been immobile. Average water particle velocities during snowmelt ranged from .00000062 to .00000011 m/sec, suggesting that direct groundwater recharge by meltwater during snowmelt was confined to areas where the premelt water table was within 1 m of the ground surface. Soil water deuterium signatures showed a rapid response to isotopically heavy rain-on-snow inputs late in the melt. In addition, spatial variations in soil moisture content at a given depth induced a pronounced lateral component to the predominantly vertical transport of water. Both factors may complicate isotopic profiles in the vadose zone, and should be considered when employing environmental isotopes to infer recharge processes during snowmelt. (Author's abstract)
W91-04103

PROCESSES OF WATER MOVEMENT THROUGH A CHALK COOMBE DEPOSIT IN SOUTHEAST ENGLAND.
Institute of Hydrology, Wallingford (England).
M. G. Hodnett, and J. P. Bell.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 361-372, October/December 1990. 6 fig, 15 ref. Water Research Center Contract R255RX.

Descriptors: *England, *Groundwater movement, *Groundwater pollution, *Groundwater recharge, *Hydraulic conductivity, *Nonpoint pollution sources, *Path of pollutants, *Soil water, Flow velocity, Interstitial water, Limestone, Nitrates, Soil water potential.

As part of an on-going experiment to monitor the movement of nitrates through chalk deposits to groundwater, the processes of water movement through the Coombe Deposit in a chalk dry valley near Eastbourne in Southeast England were investigated using simple methods based on regular weekly measurements of rainfall, soil water content, and soil water potential. The drainage flux (recharge) through the soil was determined using the water balance method during the winter and the zero flux plane (ZFP) method after the appearance of the ZFP in the spring. The unsaturated hydraulic conductivity was derived applying Darcy's Law in a novel way using the measured potential gradients and weekly drainage fluxes. The derived conductivity characteristics were adequate to identify the flow mechanisms, to illustrate the difference in behavior between the horizons of the soil profile, and to give some indication of pore water velocities. The mean daily drainage flux at 2.85 m depth during the recharge period from 10 October 1980 to 29 May 1981 was 1.6 mm/day. Weekly mean rates of up to 3.7 mm/day were observed, but peak short therm rates must have considerably exceeded this figure. It was shown that, in the lower part of the Coombe Deposit, when drainage fluxes are large, much of the flux passes through a very small proportion of the wetted cross-sectional area of the soil. This gives rise to pore water velocities of at least 3 m/day at a depth of 2.85 m and 0.5 m/day between 0.5 m and 2.5 m depth. These results show that pollutants may be moved very rapidly through the profile in this, and similar, material. The core sampling techniques normally used to monitor pollutant movement in the chalk are unlikely to succeed in detecting this movement, not only because it is transient but also because it occupies only a very small proportion of the water filled pores. (Geiger-PTT)
W91-04104

HYDROLOGY OF A HEADWATER BASIN WETLAND: GROUNDWATER DISCHARGE AND WETLAND MAINTENANCE.
York Univ., North York (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2H.
W91-04106

SULFUR ISOTOPE EVIDENCE FOR REGIONAL RECHARGE OF SALINE WATER DURING CONTINENTAL GLACIATION, NORTH-CENTRAL UNITED STATES.
Syracuse Univ., NY. Dept. of Geology.
D. I. Siegel.
Geology GLGYBA, Vol. 18, No. 11, p 1054-1056, November 1990. 3 fig, 1 tab, 16 ref.

Descriptors: *Geohydrology, *Groundwater chemistry, *Groundwater recharge, *Isotope studies, *Paleohydrology, *Saline groundwater, *Sulfur, *Tracers, Aquifer characteristics, Calcium, Chlorides, Dissolved solids, Geologic history, Glacial aquifers, Groundwater movement, Hydraulic gradient, Illinois, Sodium, Sulfates, Wisconsin.

The effect of Pleistocene glaciation on groundwater flow has recently been studied in the north-central part of the United States. In particular, groundwater in large parts of the Cambrian-Ordovician aquifer was substantially diluted by glacial meltwater recharged under hydraulic gradients controlled by the continental glaciers. However, there is an anomalous increase in concentrations of sulfate and calcium, and subordinate sodium and chloride, where the aquifer is confined by the Maquoketa Shale in southeastern Wisconsin and Northern Illinois, west of Lake Michigan. These increases in dissolved solids are anomalous because no evaporite minerals have been found in the aquifer or overlying units except as secondary nodules and fracture fillings and as finely disseminated pyrite. Coinciding with increasing sulfate concentrations, delta S34 of the dissolved sulfate increases from less than minus five parts per thousand in the unconfined part of the aquifer to a nearly constant value of twenty parts per thousand where the aquifer is confined and where sulfate reduction is minimal. The most likely source for this isotopically heavy sulfate is groundwater associated with Silurian evaporites under Lake Michigan. It is uncertain if the sulfate-rich water was emplaced in pulses or mostly during the last glaciation. It may be concluded that the chemistry of groundwater today is thus only partially related to water-rock reactions with the aquifer matrix. (Fish-PTT)
W91-04107

HYDROGEOLOGY OF AN ANCIENT ARID CLOSED BASIN: IMPLICATIONS FOR TABULAR SANDSTONE-HOSTED URANIUM DEPOSITS.
Geological Survey, Denver, CO.
R. F. Sanford.
Geology GLGYBA, Vol. 18, No. 11, p 1099-1102, November 1990. 4 fig, 29 ref.

Descriptors: *Geochemistry, *Geohydrology, *Groundwater movement, *Model studies, *Ore deposits, *Paleohydrology, *Surface-groundwater relations, *Uranium, Flow discharge, Hydrologic models, Lake sediments, Mixing, Mud flats, New Mexico, Vertical flow, Water circulation.

Tabular uranium-vanadium-copper deposits in the Chinle and Morrison Formations in the Colorado Plateau physiographic province formed from circulating groundwater; however, the hydrogeology of the ore-forming system has never been rigorously evaluated. Hydrogeologic modeling shows that tabular-type uranium deposits in the Grants uranium region of the San Juan basin, New Mexico, formed in zones of ascending and discharging regional groundwater flow. The association of either lacustrine mudstone or actively subsiding structures and uranium deposits can best be explained by the occurrence of lakes at topographic depressions where groundwater having different sources and compositions is likely to converge, mix, and discharge. Ascending and discharging flow also explains the association of uranium deposits with underlying evaporites and suggests a brine interface. The simulations contradict previous suggestions that groundwater moved downward in the mud flat. (Author's abstract)
W91-04108

CELL ANALYTICAL-NUMERICAL METHOD FOR SOLUTION OF THE ADVECTION-DISPERSION EQUATION: TWO-DIMENSIONAL PROBLEMS.
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-04124

REAL-TIME APPROACH TO MANAGEMENT AND MONITORING OF GROUNDWATER HYDRAULICS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
R. Andricevic.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2747-2755, November 1990. 8 fig, 2 tab, 30 ref.

Descriptors: *Groundwater management, *Groundwater movement, *Hydraulic conductivity, *Mathematical models, *Model studies, Groundwater resources, Monitoring, Water resources management.

Groundwater hydraulics management is used to evaluate operational policies or groundwater withdrawal strategies for managing groundwater resources. Uncontrolled temporal changes in groundwater levels may cause different problems. In some situations, developing management strategies helps aid decision makers in the proper management of groundwater resources. A sequential approach to the management and monitoring program of groundwater hydraulics was examined utilizing a model structured as a discrete time optimal control problem. The model identifies the optimal withdrawal rates by satisfying the penalty-type cost function of two conflicting objectives: satisfying withdrawal demands and maintaining target hydraulic head levels. A control action obtained in the feedback form was shown to depend on future uncertainty in hydraulic head prediction due to the variability in the hydraulic conductivity. As new field observations became available the hydraulic conductivity field was updated in real-time. A numerical example demonstrates the sequential approach and quantifies the benefits of using the monitoring program. In practice, increased emphasis is needed on identifying the objective function coefficients, regardless of the sophistication level of the management algorithm. (Mertz-PTT)
W91-04128

APPROXIMATION FOR THE BANK STORAGE EFFECT.
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-04130

DISSOLUTION OF TRAPPED NONAQUEOUS PHASE LIQUIDS: MASS TRANSFER CHARACTERISTICS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5B.
W91-04132

ABSORPTION OF WATER INTO POROUS BLOCKS OF VARIOUS SHAPES AND SIZES.
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5E.
W91-04133

IMPORTANCE OF AIR ABSORPTION DURING MECHANICAL INTEGRITY TESTING.
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
For primary bibliographic entry see Field 5G.
W91-04135

POPULATIONS AFFECTED BY PESTICIDES IN PUBLIC GROUND-WATER SUPPLIES IN IOWA.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04202

GROUND WATER, GEOMORPHIC PROCESSES, AND RIPARIAN VALUES: SAN PEDRO RIVER, ARIZONA.
Bureau of Land Management, Phoenix, AZ. Arizona State Office.
For primary bibliographic entry see Field 6G.
W91-04218

MICROBIAL ACTIVITY IN THE TERRESTRIAL SUBSURFACE.
Pennsylvania State Univ., University Park. Lab. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-04263

HYDROTHERMAL PETROLEUMS FROM YELLOWSTONE NATIONAL PARK, WYOMING, USA.
Oregon State Univ., Corvallis. Coll. of Oceanography.
C. G. Clifton, C. C. Walters, and B. R. T. Simoneit.
Applied Geochemistry APPGEY, Vol. 5, No. 1/2, p 169-191, June/March 1990. 10 fig, 5 tab, 126 ref. NSF Grants OCE-8512832 and OCE-8601316.

Descriptors: *Geochemistry, *Groundwater chemistry, *Hydrocarbons, *Hydrothermal studies, *Oil, *Oil characterization, *Thermal springs, *Yellowstone National Park, Aromatic compounds, Chemical interactions, Heterocyclic compounds, Organic geochemistry, Petroleum, Polar compounds, Pyrolysate, Sedimentary rocks, Steam vents.

In Yellowstone National Park, oil is actively discharging with thermal waters at several widely separated thermal areas. Samples from two locations were studied. Petroleum from Calcite Springs occurs as vapor condensates in steam vents. Deeply buried, hydrothermally altered sedimentary rocks are believed to have contributed a high temperature pyrolysate consisting largely of polynuclear aromatic hydrocarbons and heterocyclic compounds. Shallow sedimentary rocks, which are also hydrothermally altered, have contributed large amounts of aromatic and polar compounds, as well as minor amounts of hydrocarbons. Autochthonous pyrolysates and lipids from thermally altered surface and near surface bacterial and land plant debris have also been introduced to the vents by downward percolating meteoric water. The oil from Rainbow Springs is a highly paraffinic, low-S crude oil, depleted in light hydrocarbons. Unlike the Calcite Springs samples, the oil from Rainbow Springs is believed to have originated from a single sedimentary source rock with little or no hydrocarbon contributions from surface biota. Consideration of the petroleum chemistry and regional hydrodynamics indicates that the Yellowstone Park oils did not migrate into the Park from distant sources. The chemical data are also inconsistent with the oils being generated and trapped prior to Tertiary volcanism. At both Calcite Springs and Rainbow Springs, oil generation appears to be contemporaneous and is attributed to thermal alteration of relatively shallow sedimentary rocks by hydrothermal fluids. (Author's abstract)
W91-04270

PORE-WATER GEOCHEMISTRY AND THE MINERALOGY OF THE VADOSE ZONE OF SULFIDE TAILINGS, WAITE AMULET, QUEBEC, CANADA.
Waterloo Centre for Groundwater Research (Ontario).
For primary bibliographic entry see Field 5B.
W91-04271

HYDROGEOLOGICAL MODEL FOR AMADEUS BASIN AQUIFERS, CENTRAL AUSTRALIA.
Birmingham Univ. (England). School of Earth Sciences.
D. M. Brown, J. W. Lloyd, and G. Jacobson.
Australian Journal of Earth Sciences AJESE7, Vol. 37, No. 2, p 215-226, June 1990. 7 fig, 6 tab, 14 ref.

Descriptors: *Australia, *Geohydrology, *Groundwater basins, *Groundwater movement, *Hydrologic models, *Model studies, *Paleohydrology, Amadeus Basin, Flow rates, Groundwater data, Groundwater depletion, Groundwater flow, Groundwater recharge, Hydrogeological model, Paleo-recharge, Simulation analysis.

A two-dimensional vertical section hydrogeologic model has been developed to simulate the groundwater head distribution in three major aquifers of the Amadeus Basin, central Australia. The model indicates an uneven distribution of groundwater flow rate within each aquifer, partly caused by the complex structural configuration of the basin. The model-derived velocity profile indicates groundwater flow times along a 250 km long and 6000 m deep section to be several million years. Present day regions of slow groundwater flow may be influenced by paleo-recharge pulses derived from formation outcrops and transmission losses in major rivers. A wetter climate over an extended period of the Early Tertiary is indicated by the presence a formerly integrated drainage system in the Amadeus Basin. Simulation of groundwater head conditions during the Early Tertiary was undertaken to investigate the possible effects of paleo-recharge on the present day basin. Simulation of wetter conditions with greater groundwater recharge in Early Tertiary indicates reduced groundwater flow rates and also reversals of flow direction. The present-day groundwater flow regime is still recovering from Early Tertiary process, and the longevity of paleo-recharge effects may be of the order of 50 Ma. (Korn-PTT)
W91-04273

ENVIRONMENTAL RESEARCH FIELD SITE 'HORKHEIMER INSEL': RESEARCH PROGRAM, INSTRUMENTATION AND FIRST RESULTS.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 7A.
W91-04308

CAN CONTAMINATED, FRACTURED, POROUS AQUIFERS BE RESTORED.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 5G.
W91-04311

LAND CLEARANCE AND RIVER SALINISATION IN THE WESTERN MURRAY BASIN, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4C.
W91-04386

SOLUTE AND HEAT TRANSPORT EXPERIMENTS FOR ESTIMATING RECHARGE RATE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
M. Taniguchi, and M. L. Sharma.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 57-69, November 1990. 7 fig, 3 tab, 22 ref.

Descriptors: *Groundwater recharge, *Infiltration, *Recharge, *Tracers, Bromides, Groundwater movement, Heat transport, Hydraulic conductivity, Soil water, Solute transport.

To determine groundwater recharge rate from a tracer experiment, it is important to know the fraction of mobile water, because the soil water flux is estimated using the pore water velocity and the mobile water content. The latter is defined as the 'effective water' involved in the transport of the bulk of the tracer. In the field it is possible to measure only velocities and total water content, making it necessary to examine the relationship between total and mobile water content. To examine the relationship between mobile water content and water flux during infiltration, laboratory experiments were conducted for simultaneous transport of solute (bromide) and heat using columns of two soils, Bassendean sand and Collie loam. Within a limited water flux range, for the same flux the

mobile water fraction was lower for the sand than for the loam. The mobile fraction of soil water increased with increasing water flux for sand but was relatively constant for loam. These results have significant implications in field estimations of deep drainage (recharge rate) using tracer techniques, and also in the development of empirical expressions for the relationship between unsaturated hydraulic conductivity and the effective saturation of specific soils. Estimates of water flux based on the analysis of soil temperature changes agreed well with those based on the solute tracer. This agreement was closest when water flux using solute was calculated using the mobile water content and the heat capacity for the temperature method was calculated using the total water content. (Author's abstract)
W91-04390

GROUNDWATER RESOURCES DEVELOPMENT IN THE EASTERN SAHARA.
Birmingham Univ. (England). Hydrogeology Section.
For primary bibliographic entry see Field 4B.
W91-04391

ANALYSIS OF FLOW NEAR A DUG WELL IN AN UNCONFINED AQUIFER.
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
K. Sridharan, D. Sathyanarayana, and A. S. Reddy.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 89-103, November 1990. 13 fig, 9 ref.

Descriptors: *Drawdown, *Groundwater movement, *Model studies, *Unconfined aquifers, *Wells, Anisotropy, Hydraulic conductivity, Mathematical models, Numerical analysis, Seepage, Water table decline, Well yield.

The numerical solutions reported in the literature for flow near a large-diameter dug well involve various approximations of the boundary condition at the water table, seepage surface at the well face, vertical flow, well penetration, and distribution of hydraulic gradient. Most also ignore the flow contribution from the bottom surface of the well. A numerical analysis was conducted of flow to dug well in an unconfined aquifer. The analysis considers well storage, elastic storage release, gravity drainage, anisotropy, partial penetration, vertical flow, and seepage surface at the well face; it also treats the water table in the aquifer and the water level in the well as unknown boundaries. The pumped discharge is maintained constant. The solution is obtained by a two-level iterative scheme. The effects of governing parameters on the drawdown, development of seepage surface and contribution from aquifer flow to the total discharge are discussed. The degree of anisotropy and partial penetration are found to be the parameters that affect the flow characteristics most significantly. The effect of anisotropy on the development of seepage surface is very pronounced. The degree of anisotropy is the most significant factor influencing the development of the seepage surface, with a pronounced seepage surface for relatively low vertical hydraulic conductivity. In general, the effects of change in specific yield and elastic storage coefficient are much less significant than those of anisotropy or well penetration. The drawdown variation with discharge is not strictly linear. Depending on the aquifer parameters, well penetration and the discharge rate, the relative contribution from aquifer parameters, well penetration, and the discharge rate, the relative contribution from aquifer flow may approach the total pumping rate or may be only a small fraction of it even when the well becomes completely drained. (Rochester-PTT)
W91-04392

GROUNDWATER-LAKE INTERACTIONS: I. ACCURACY OF SEEPAGE METER ESTIMATES OF LAKE SEEPAGE.
Alberta Univ., Edmonton. Dept. of Zoology.
For primary bibliographic entry see Field 7B.
W91-04393

GROUNDWATER-LAKE INTERACTIONS: II. NEARSHORE SEEPAGE PATTERNS AND THE CONTRIBUTION OF GROUND WATER TO LAKES IN CENTRAL ALBERTA.
Alberta Univ., Edmonton. Dept. of Zoology.
R. D. Shaw, and E. E. Prepas.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 121-136, November 1990. 3 fig, 4 tab, 38 ref.

Descriptors: *Alberta, *Groundwater movement, *Lakes, *Seepage, *Surface-groundwater relations, Glacial aquifers, Measuring instruments.

Seepage flux was measured with seepage meters placed along transects from the lake shore to 30-100 m offshore in ten lakes in Alberta during May-August 1986. In the study area, the predominant surficial deposit is glacial till that is underlain by sedimentary bedrock. Seepage flux into the lakes ranged from 3 x 10 to the minus 9th power to 2 x 10 to the minus 7th power m/sec. Seepage out of the lakes was recorded at only one of the 92 seepage meter sites. At one lake, seepage was measured fortnightly along transects at two locations, from May to August 1986; seepage patterns were consistent throughout that period. In the nearshore region of 6 of the 10 lakes, seepage flux to the lakes decreased with distance from shore. Deviations from that pattern probably resulted from: (1) spatial variability of seepage flux within a small area of lake bed; (2) intertill sand and gravel lenses near the lake; and (3) preglacial bedrock channels of sand and gravel underlying some of the lakes. Ground water was the major source of water (49% of total inflow) to one lake. At the other lakes ground water was a relatively small component (10%) of total inflow. (See also W91-04393) (Author's abstract)
W91-04394

SOLUTIONS OF ONE-DIMENSIONAL WATER FLOW AND MASS TRANSPORT EQUATIONS IN VARIABLY SATURATED POROUS MEDIA BY THE FINITE ELEMENT METHOD.
Thessaloniki Univ., Salonika (Greece). School of Agriculture.
For primary bibliographic entry see Field 5B.
W91-04396

APPLICATION OF FACTOR ANALYSIS TO THE HYDROGEOCHEMICAL STUDY OF A COASTAL AQUIFER.
Alicante Univ. (Spain). Div. de Ingenieria Quimica.
F. Ruiz, V. Gomis, and P. Blasco.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 169-177, November 1990. 5 fig, 2 tab, 6 ref.

Descriptors: *Coastal aquifers, *Factor analysis, *Geochemistry, *Saline water intrusion, *Spain, Alicante, Bicarbonates, Bromides, Chlorides, Hydronium ion, Ions, Magnesium, Mathematical analysis, Potassium, Sodium, Water chemistry.

The basic purpose of R-mode factor analysis applied to the study of the hydrogeochemistry of an aquifer is to find a set of factors, few in number, which explain a large part of the variance in the analytical data. The input data often are transformed to logarithms because the original data often have a lognormal rather than a normal distribution. However, it is shown that the use of numerical values for the chemical components of waters from an aquifer as input data for factor analysis is sometimes more convenient than the use of logarithms of these figures. Factor analysis was applied to the hydrogeochemical study of a coastal aquifer located in Javea, Alicante (Spain). A set of factors was found that explained the source of the ions in the water and even certain chemical processes that accompany the intrusion of seawater, such as the strong adsorption of K on clay minerals. The four main factors were: (1) high loadings of Br(-), Cl(-), Na(+) and Mg(2+), whose concentration in seawater is much greater than that in continental water; (2) mainly nitrate; (3) HCO3(-) and H3O(+) concentrations; and (4) the variable K(+). (Rochester-PTT)
W91-04397

GROUNDWATER RESPONSE TO REFORESTATION IN THE DARLING RANGE OF WESTERN AUSTRALIA.
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 4C.
W91-04398

EXAMINATION OF COMPUTED STEADY-STATE WATER-TABLE HEIGHTS IN UNCONFINED AQUIFERS: DUPUIT-FORCHHEIMER ESTIMATES AND EXACT ANALYTICAL RESULTS.
E. G. Youngs.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 201-214, November 1990. 9 fig, 18 ref.

Descriptors: *Aquifers, *Groundwater movement, *Mathematical equations, *Model studies, *Seepage, *Unconfined aquifers, *Water table, Accuracy, Calculations, Dupuit-Forchheimer theory, Laplaces equation.

For over a century, engineers have used the Dupuit-Forchheimer theory to calculate water-table heights and horizontal seepage rates in shallow, unconfined aquifers. The precision with which water table heights are given by Dupuit-Forchheimer analysis was examined by comparing calculated water table heights with those obtained by exact solution of Laplace's equation for boundary conditions that are approximately the same in both cases. The Dupuit-Forchheimer solutions for flow through a vertically-sided earth bank with no tailwater and for drainage to parallel ditches sunk to a horizontal impermeable floor approximate that given by Konzeny's parabola solution for groundwater flow to a horizontal toe drain and to that given by Engelund's solution for drainage of uniform rainfall to horizontal drains, respectively, except in the vicinity of the drains. In both situations, the water table height given by the analytical solution immediately above the beginning of the horizontal drains is a good estimate of the height of the seepage surface that the Dupuit-Forchheimer analysis ignores. The Dupuit-Forchheimer analysis apparently gives water table heights closer to the true values when there is tail water. When water seeps from ditches to feed evaporation from the soil surface, there is not seepage surface and the Dupuit-Forchheimer water table prediction is not very different from the true value. For soils with hydraulic conductivity varying with height, the Girinsky potential allows water table heights to be calculated making use of the Dupuit-Forchheimer assumption and gives more accurate estimates when the hydraulic conductivity increases with height. (Author's abstract)
W91-04399

RELATIONSHIPS IN REGIONAL GROUNDWATER DISCHARGE TO STREAMS: AN ANALYSIS BY NUMERICAL SIMULATION.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2A.
W91-04400

STATISTICAL ANALYSIS OF THE HYDROCHEMISTRY OF GROUND WATERS IN COLUMBIA RIVER BASALTS.
Idaho Univ., Moscow. Coll. of Mines and Earth Resources.
R. A. Riley, R. K. Steinhorst, G. V. Winter, and R. E. Williams.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 245-262, November 1990. 7 fig, 1 tab, 19 ref.

Descriptors: *Aquifers, *Geochemistry, *Groundwater chemistry, *Groundwater movement, *Statistical analysis, *Washington, *Water chemistry, Cluster analysis, Columbia River basalts, Groundwater divide, Hanford Nuclear Reservation, Radioactive waste disposal, Water classification.

The geometry of flow paths and the directions of groundwater movement in the Saddle Mountains, Wanapum, and Grande Ronde Basalts at the Hanford site are not well understood. Multivariate cluster analysis (MANOVA), a canonical analysis, and discriminant analysis were used to investigate

the directions of groundwater movement in the Saddle Mountains and the Grande Ronde Formations near the Hanford Nuclear Reservation, Washington. Hydrochemistry data constituted the data base. The statistical analyses indicate that the hydrochemistry of the groundwaters in these basalt formations is distinctly different on each side of the Columbia River where the river passes through the Hanford Reservation. A continuous groundwater flow system passing beneath the river would be expected to display hydrochemically similar groundwaters on both sides of the river. The hydrochemically distinct groundwaters on opposite sides of the river suggest that the river is the groundwater divide or that the river is roughly coincident with a hydrogeologic barrier boundary. In addition, the hydrochemistry of groundwater in each of the basalt formations is statistically relatively distinct on the Hanford Reservation west of the river. This distinctness of groundwater among basalt formations is not evident east of the river. The statistical procedures used in this study are a quantitative means of differentiating groundwaters by hydrochemistry. (Author's abstract)
W91-04401

PROPAGATION OF A WAVE PACKET ON A FREE SURFACE WITHIN A SATURATED POROUS LAYER.
Universidad Central de Venezuela, Caracas. Inst. de Mecanica de Fluidos.
H. Power.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 263-270, November 1990. 6 ref.

Descriptors: *Groundwater movement, *Porous media, *Saturated flow, *Wave propagation, Mathematical analysis, Wave height, Wavelengths, Waves.

When water flows through a porous medium in response to a pressure gradient, it flows through the irregularly arranged interstices. Practical problems of unsteady flow found in the literature include flow inside a porous dam. Propagation of a linear wave on the free surface of a liquid saturating a porous layer was analyzed, with the aim of discovering the rate of decay of the amplitude with time and distance. It is shown that for a single periodic progressive wave of frequency w and wave number k, the amplitude dies out in a short distance compared with the wavelength. However, superimposing several such waves of different frequency can propagate for a relatively long distance before dying out. In nature, wave phenomena always are present as a group and not in a single mode. Therefore, it is concluded that it is possible to have propagation in the form of a wave packet at the free surface of a saturated porous layer that travels a relatively long distance before dying out. (Rochester-PTT)
W91-04402

RELATIONSHIPS BETWEEN GROUNDWATER CONTAMINATION AND MAJOR-ION CHEMISTRY IN A KARST AQUIFER.
Kentucky Univ., Lexington.
For primary bibliographic entry see Field 5B.
W91-04403

GROUNDWATER EXCHANGE RATE OF THE SOUTHERN BALTIC COASTAL LOWLAND.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
K. Burzynski, and A. Sadurski.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 293-306, November 1990. 11 fig, 16 ref.

Descriptors: *Coastal aquifers, *Connate water, *Groundwater movement, *Peat bogs, *Poland, *Surface-groundwater relations, *Wetlands, Baltic Sea, Bielawskie Blota, Mathematical models, Soil water.

The groundwater of the southern Baltic lowlands usually occurs in particular hydrogeological conditions. The lowland is covered mostly by peats several meters in thickness. Peat bog water is isolated from deeper aquifers and has different chemical composition. Salty, relict groundwater of marine origin from the Atlantic period of the Holocene (Littorina transgression) may have survived in the deeper coastal aquifers in places of sluggish flow. The area called Bielawskie Blota is on the eastern part of the belt of the southern Baltic coastal lowland near Ostrowa (Poland). The peat bog located in the middle of the depression is the most easterly Atlantic-type bog and contains relict plant species of the arctic and subarctic climates. A water-dynamics analysis was conducted to provide the data needed for maintenance of the optimum soil water conditions. A mathematical model of groundwater flow was used that is based on Boussinesq's equation for steady and unsteady flow. Dupuit's principle was used in the model for unsteady flow. The solution was obtained by the finite element method. The results of mathematical modelling of groundwater flow circulation show that the flow rate and local directions of groundwater flow change during the year, depending on the rate of groundwater recharge by precipitation. The unsteady flow model was developed to make it possible to predict the water table fluctuations during a year at any point of the area studied. The calculation of the groundwater exchange rate did not confirm the presence of any places of very sluggish groundwater flow, where salty, young relict water might have survived. (Rochester-PTT)
W91-04404

DEUTERIUM-CALIBRATED GROUNDWATER FLOW MODEL OF A REGIONAL CARBONATE-ALLUVIAL SYSTEM.
Nevada Univ. System, Las Vegas. Water Resources Center.
S. T. Kirk, and M. E. Campana.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 357-388, November 1990. 15 fig, 6 tab, 27 ref.

Descriptors: *Alluvial aquifers, *Environmental tracers, *Groundwater movement, *Hydrologic models, *Model studies, *Nevada, *Tracers, Carbonates, Coyote Spring Valley, Deuterium, Groundwater dating, Groundwater recharge, Isotope studies, Lower Meadow Valley, Mathematical models, Sheep Range, Upper Moapa Valley, White River.

The White River Flow System (WRFS), a regional carbonate-alluvial groundwater system in southeastern Nevada, contains large amounts of water in storage, especially in the underlying carbonate reservoir. As the population of Nevada grows, it may become necessary to tap the resources of this and other regional carbonate systems. A simple mixing-cell flow model of the WRFS was constructed and calibrated with the spatial distribution of the stable isotope deuterium. This model provides estimates of recharge rates, groundwater ages, and volumes of water in storage. The lack of constraints on the system mandates the calibration of three different flow scenarios, each of which differs slightly from the other. Despite these differences, some consistent quantitative results were obtained, including: (1) the carbonate aquifer may contain as much as 752 cu km of water in storage; (2) recharge from the Sheep Range to Coyote Spring Valley is at least 90% greater than previously believed; (3) Lower Meadow Valley is part of the WRFS and contributes underflow to Upper Moapa Valley; (4) underflow with an average value of 0.163 cu m/sec flows westward out of the system along the Pahranagat Shear Zone; (5) recharge to the alluvial system is greater than that to the carbonate system; (6) groundwater mean ages range from 1600 to 34,000 years, with the oldest waters exceeding 100,000 years old. The results also demonstrate that deuterium can be used to calibrate simple flow models and provide groundwater ages. Despite the uncertainties and lack of constraints in mixing-cell models, they provide first approximations to information which, until now, has been difficult, if not impossible, to obtain. These models are especially useful for analyzing sparse-data systems, testing different flow hypotheses with minimal effort, providing ranges in parameter estimates, guiding future data collection, and serving as precursors for the development of more sophisticated models. (Author's abstract)
W91-04407

GEOTHERMAL RESOURCES OF THE WESTERN ARM OF THE BLACK ROCK DESERT, NORTHWESTERN NEVADA: PART II, AQUEOUS GEOCHEMISTRY AND HYDROLOGY.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2K.
W91-04462

CONCEPT OF THE SHALLOW GROUNDWATER SYSTEM ALONG THE NORTH PLATTE RIVER, SOUTH-CENTRAL WYOMING.
Geological Survey, Cheyenne, WY. Water Resources Div.
M. A. Crist.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4078, 1990. 23p, 9 fig, 3 tab, 2 pl, 16 ref.

Descriptors: *Groundwater budget, *Irrigation, *North Platte River, *Stream discharge, *Surface-groundwater relations, *Water level, *Wyoming, Aquifers, Hydrographs, Pumpage.

Irrigation along the North Platte River in Wyoming began as early as 1875. Streams are the principal source of irrigation water with groundwater used to supplement surface-water irrigation supplies. There was concern that groundwater pumpage may have caused about 16 ft of water-level decline in an observation well over a 2-year period. Leakage or lack of leakage from surface-water diversions for irrigation probably affects groundwater levels much more than pumpage. This study includes a quantitative assessment of the groundwater system for an area of approximately 410 sq mi along the North Platte River. Inflow to groundwater in the study area was estimated to average about 15 cu ft/sec from precipitation, about 36 cu ft/sec from stream leakage and surface-water irrigation, and about 39 cu ft/sec from leakage of streams and surface-water irrigation outside the study area. Groundwater outflow from the study area was estimated to average about 90 cu ft/sec assuming steady-state conditions. (USGS)
W91-04463

GROUND-WATER RESOURCES OF HONEY LAKE VALLEY, LASSEN COUNTY, CALIFORNIA, AND WASHOE COUNTY, NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
E. H. Handman, C. J. Londquist, and D. K. Maurer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4050, 1990. 112p, 30 fig, 19 tab, 4 pl, 84 ref.

Descriptors: *Aquifers, *Geohydrology, *Groundwater availability, *Groundwater movement, *Groundwater recharge, *Groundwater resources, *Model studies, *Nevada, California, Computer models, Evapotranspiration, Groundwater, Honey Lake Valley.

Honey Lake Valley is a 2,200 sq-mi, topographically closed basin about 35 miles northwest of Reno, Nevada. Unconsolidated basin-fill deposits on the valley floor and fractured volcanic rocks in northern and eastern uplands are the principal aquifers. In the study area, about 130,000 acre-ft of water recharges the aquifer system annually, about 40% by direct infiltration of precipitation and about 60% by infiltration of streamflow and irrigation water. Balancing this is an equal amount of groundwater discharge, of which about 65% evaporates from the water table or is transpired by phreatophytes, about 30% is withdrawn from wells, and about 5% leaves the basin as subsurface outflow to the east. Results of a groundwater flow model of the eastern part of the basin, where withdrawals for public supply have been proposed, indicate that if 15,000 acre-ft of water were withdrawn annually, a new equilibrium would eventually be established by a reduction of about 60% in both evapotranspiration and subsurface outflow to the east. Hydrologic effects would be minimal at

the western boundary of the flow-model area. Within the modeled area, the increased withdrawals cause an increase in the simulated net flow of groundwater eastward across the California-Nevada State line from about 670 acre-ft/yr to about 2,300 acre-ft/yr. (USGS)
W91-04466

GROUND-WATER WITHDRAWALS, WATER-LEVEL CHANGES, LAND-SURFACE SUBSIDENCE, AND GROUND-WATER QUALITY IN FORT BEND COUNTY, TEXAS, 1969-87.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 4B.
W91-04467

HYDROGEOLOGY AND GROUND-WATER-QUALITY CONDITIONS AT THE EMPORIA-LYON COUNTY LANDFILL, EASTERN KANSAS, 1988.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04468

THREE COMPUTERIZED, STRATIFIED RANDOM SITE-SELECTION METHODS FOR DESIGN OF A GROUND-WATER-QUALITY SAMPLING NETWORK.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7A.
W91-04470

GROUND-WATER FLOW IN THE NEW JERSEY COASTAL PLAIN.
Geological Survey, Trenton, NJ. Water Resources Div.
M. Martin.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 87-528, 1990. 182p, 91 fig, 15 tab, 50 ref.

Descriptors: *Groundwater movement, *Model studies, *Simulation analysis, Aquifer characteristics, Coastal aquifers, Computer models, Confining beds, Groundwater level, Hydrologic budget, Saline water intrusion, Saline-freshwater interfaces, Surface-groundwater relations.

Flow was simulated in 10 aquifers of the New Jersey Coastal Plain using a multilayer finite-difference model for prepumping steady-state conditions and transient conditions from 1896-1981. The highest transmissivity, greater than 10,000 sq ft/day, is in Camden and Gloucester Counties in the Potomac-Raritan-Magothy aquifers; Monmouth and Ocean Counties in the middle aquifer of the Potomac-Raritan Magothy aquifer system; and Ocean, Burlington, Atlantic, and Cape May Counties in the Kirkwood-Cohansey aquifer system. Confining unit leakance is highest, > than 0.001 ft/day/ft in updip areas and lowest, < 0.00001 ft/day/ft, in downdip areas. Areas near the center of the major cones of depression approximate steady-state conditions. However, downdip and offshore areas are under transient conditions. Simulated head changes along the saltwater-freshwater interface boundary indicate that the lower aquifer of the Potomac-Raritan-Magothy aquifer system and the confined Kirkwood aquifer have the greatest potential for updip movement of chlorides. The simulated sources of water to wells in 1978 include: (1) 3% from aquifer storage; (2) 3% from boundary flows; (3) 4% from the ocean and bays; and (4) 90% from streamflow. (USGS)
W91-04471

GROUND-WATER LEVELS IN WATER YEAR 1987 AND ESTIMATED GROUND-WATER PUMPAGE IN WATER YEARS 1986-87, CARSON VALLEY, DOUGLAS COUNTY, NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
D. L. Berger.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-70, 1990. 9p, 1 fig, 2 tab, 1 pl, 3 ref.

Descriptors: *Carson Valley, *Groundwater availability, *Groundwater resources, *Hydrologic data, *Nevada, *Surface-groundwater relations, *Water resources data, Carson River Basin, Douglas County, Groundwater level, Groundwater pumpage.

Groundwater levels were measured at 58 wells during water year 1987 and a summary of estimated pumpage is given for water years 1986 and 1987 in Carson Valley, Douglas County, Nevada. The data were collected to provide a record of groundwater changes over the long-term and pumpage estimates that can be incorporated into an existing groundwater model. The estimated total pumpage in water year 1986 was 10,200 acre-ft and in water year 1987 was 13,400 acre-ft. Groundwater levels exhibited seasonal fluctuations but remained relatively stable over the reporting period throughout most of the valley. (USGS)
W91-04474

GROUND-WATER-QUALITY ASSESSMENT OF THE CARSON RIVER BASIN, NEVADA AND CALIFORNIA: ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2K.
W91-04476

DOCUMENTATION OF MODEL INPUT AND OUTPUT VALUES FOR THE GEOHYDROLOGY AND MATHEMATICAL SIMULATION OF THE PAJARO VALLEY AQUIFER SYSTEM, SANTA CRUZ AND MONTEREY COUNTIES, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 4B.
W91-04477

PURGEABLE ORGANIC COMPOUNDS IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO--1988 AND 1989.
Geological Survey, Idaho Falls, ID. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04478

GROUND-WATER LEVELS IN THE ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1989.
Geological Survey, Little Rock, AR. Water Resources Div.
P. W. Westerfield, and C. R. Baxter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-558, 1990. 35p, 2 fig, 1 tab, 21 ref.

Descriptors: *Alluvial aquifers, *Arkansas, *Groundwater level, *Mississippi River Valley Alluvial Aquifer, Data collections, Mississippi Alluvial Plain, Water resources data.

This report, prepared by the U.S. Geological Survey in cooperation with the Arkansas Soil and Water Conservation Commission, the U.S. Soil Conservation Service and local Conservation Districts, contains groundwater level measurements of 504 wells that tap the alluvial aquifer in the Quaternary deposits of the Mississippi Alluvial Plain. The measurements were made by district Soil Conservation Service personnel during 1989. The shallowest prepumping season water levels occurred in Clay, Greene, Independence, Mississippi, Phillips, and Randolph Counties where water levels averaged less than 20 ft below the land surface. The deepest water levels occurred in Arkansas, Lonoke, Poinsett, and Prairie Counties where water levels of more than 100 ft were measured. Water levels in the postpumping season averaged about 2.5 ft lower than during the prepumping season. (USGS)
W91-04479

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1989.
Geological Survey, Bow, NH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04480

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1989.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04481

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1989.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04483

GEOHYDROLOGY AND WATER QUALITY OF CONFINED-DRIFT AQUIFERS IN THE BROOTEN-BELGRADE AREA, WEST-CENTRAL MINNESOTA.
Geological Survey, St. Paul, MN.
G. N. Delin.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations 88-4124, 1990. 138p, 61 fig, 11 tab, 44 ref, 3 append. Prepared in cooperation with the Minnesota Department of Natural Resources and the Western Minnesota Resource Conservation and Development Association.

Descriptors: *Confined aquifers, *Geohydrology, *Groundwater movement, *Groundwater quality, *Water quality, *Water resources data, Aquifer systems, Chippewa River, Crow River, Dissolved solids, Iron, Manganese, Minnesota, Model studies, Sauk River, Water level, Well yield.

Confined-drift aquifers in six aquifer zones identified in a 1,300-sq mi area of west-central Minnesota near Brooten and Belgrade range in thickness from 5 to 110 ft. Transmissivities generally range from 500 to 10,000 sq ft/day, and theoretical well yields generally range from 100 to 900 gal/min. Regional groundwater flow in the confined-drift aquifers is to the southeast with local discharge to the East and Middle Branches of the Chippewa River, the North Fork Crow and Sauk Rivers, and to smaller streams, lakes, wetlands, and wells. Water levels near high-capacity pumped wells generally fluctuate 5 to 40 ft annually, compared to annual fluctuations of less than 5 ft in the unconfined aquifer. Water from confined-drift aquifers generally is suitable for most uses. The water is hard to very hard and contains locally elevated concentrations of iron, manganese, and dissolved solids. Results from a groundwater flow model indicate that increased pumping from confined aquifers in the area would not adversely affect water levels. The addition of 10 to 20 hypothetical wells, pumping 123 to 246 million gal/year, generally resulted in regional water level declines of 0.1 to 1.0 ft. Simulations showed that the reduced recharge and increased pumping resulting from a 3-year drought probably would lower water levels between 5 and 10 ft regionally in the confined-drift aquifers, and as much as 20 ft locally in the unconfined aquifer. Groundwater discharge to the East Branch Cippewa and North Fork Crow Rivers during the simulated drought would be reduced by 38% of 1984 conditions. (Author's abstract)
W91-04635

MATRIX-CONTROLLED HYDRAULIC PROPERTIES OF MISSISSIPPIAN AND PENNSYLVANIAN SANDSTONES FROM THE MICHIGAN BASIN.

Geological Survey, Lansing, MI.
D. B. Westjohn, H. W. Olsen, and A. T. Willden.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Open-File Report 90-104, 1990. 18p, 2 fig, 3 tab, 6 ref, append.

Descriptors: *Aquifer systems, *Geohydrology, *Hydraulic properties, *Sandstones, Hydraulic conductivity, Rock properties, Stress.

Hydraulic conductivity measurements were made of 49 sandstone core plugs using a flow pump and a conventional triaxial confining apparatus. The sandstones tested are samples from the Marshall Sandstone and Grand River and Saginaw Formations, which are the principal bedrock aquifers in the Michigan basin. Sandstones ranging from poorly cemented to well cemented were selected to investigate matrix-controlled hydraulic properties as a function of degrees of cementation. Hydraulic conductivities were measured for each sample over a range of effective stress (69 to 827 kp); hydraulic conductivities for the sample suite ranged from 0.019 to 0.0000000027 cm/sec. This range of approximately seven orders in magnitude is indicative of local and regional differences in matrix-controlled hydraulic conductivities for Mississippian and Pennsylvanian bedrock aquifers in the Michigan basin. (Author's abstract)
W91-04639

GROUNDWATER RESOURCES OF PIKE COUNTY, PENNSYLVANIA.
Geological Survey, Harrisburg, PA.
D. K. Davis.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. Pennsylvania Geological Survey Water Resources Report 65, 1989. 63p, 15 fig, 24 tab, 29 ref, 2 pl. Prepared by the United States Geological Survey, Water Resources Division, in cooperation with the Pennsylvania Geological Survey.

Descriptors: *Geohydrology, *Groundwater resources, *Pennsylvania, *Water resources data, Aquifers, Groundwater level, Groundwater quality, Hydrogen ion concentration, Iron, Manganese, Pike County, Seasonal variation, Specific capacity, Well yield.

Pike County is a 545-sq mi area in northeastern Pennsylvania where outdoor recreation is the principal activity. Bedrock consists of Middle and Upper Devonian sedimentary rocks that dip 1 to 10 degrees to the northwest. Most of the bedrock is covered with glacial till or ground moraine deposited during the Pleistocene Epoch. Unconsolidated valley-fill deposits are up to 5000 ft thick along the Delaware River. Groundwater levels fluctuate in response to precipitation and evapotranspiration. Water levels generally decline during the summer season and recover during the winter season. The median depth to water in unconsolidated deposits is 30 ft below land surface; in consolidated rocks it ranges between 28 and 35 ft below land surface. Water is found primarily in faults, joints, and bedding planes in consolidated rocks and in intergranular openings in unconsolidated deposits. The thickness of the freshwater system is > 800 ft. Most wells are domestic and have depths that range from 8 to 1,200 ft and reported yields that range from 1 to 150 gal/min. Most wells are in consolidated-rock aquifers; however, wells in unconsolidated deposits have potentially larger yields. Specific capacities of nondomestic wells in unconsolidated deposits range from 1.4 to 30 gal/min/ft, whereas specific capacities of nondomestic wells in consolidated-rock aquifers range from 0.001 to 10 gal/min/ft. Water quality is generally good and suitable for most uses. The median specific conductance of water from most aquifers is < 200 micromhos/cm. Hardness is generally < 80 mg/L (as calcium carbonate). Median values of pH range from 6.3 to 8.0. Water quality problems are related primarily to elevated concentrations of iron and manganese. In 59 water samples, dissolved iron ranged from 0 to 2,500 microg/L; in 58 water samples, dissolved manganese ranged from < 1 to 820 microg/L. (Author's abstract)
W91-04641

WATER RESOURCES OF THE ELK RIVER BASIN, WEST VIRGINIA.
Geological Survey, Morgantown, WV. Water Resources Div.
M. V. Mathes, and S. M. Ward.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. 1990. 37p, 17 fig, 11 tab, 37 ref. Prepared by the United States Geological Survey in cooperation with the West Virginia Geological and Economic Survey and the West Virginia Department of Natural Resources Division of Water Resources.

Descriptors: *Elk River Basin, *Geohydrology, *Groundwater resources, *Water quality, *Water resources, *Water resources data, *West Virginia, Chlorides, Drinking water, Groundwater quality, Hydrologic budget, Iron, Manganese, Specific capacity, Streamflow, Virginia, Well yield.

The water resources of the Elk River basin are used by 12% of the population of West Virginia. In 1984, more than 9 billion gallons of water were withdrawn from the basin--8.5 billion gallons of surface water and 0.5 billion gallons of groundwater. The Elk River basin is located in central West Virginia and drains 1,533 sq mi. The basin is predominantly forests, although other land uses include the mining of coal and the extraction of oil and gas. Groundwater is the primary source of drinking water for rural residents of the basin. Reported well yields ranged from 0.08 to 1,000 gal/min. The aquifers in Lower Pennsylvanian and Mississippian rocks yielded the most water based on median well yields. Estimated specific capacities ranged from 001 to 5 gal/min/ft of drawdown. Reported well yield and estimated specific capacity generally were greater for valley wells than for hillside and hilltop wells. Groundwater quality varied with respect to topography and geohydrologic unit. Hilltop wells yielded water with lower pH, lower concentrations of iron, and higher concentrations of hardness and sulfate than valley wells. Water from the Pottsville Group in aquifers in the Lower Pennsylvanian rocks was softer, more acidic, and had higher concentrations of dissolved iron and manganese than water from other geohydrologic units. Water from the Conemaugh Group in aquifers in the Upper Pennsylvanian rocks was the most mineralized. The mean annual outflow of the Elk River is about 2,300 cu ft/sec, which is equivalent to 21 inches of runoff. Streamflow in the lower reaches of the Elk River has been regulated by Sutton Reservoir since 1960. The reservoir has decreased the magnitude of flood peaks and has augmented low flow. Water in the Elk River and its major tributaries is poorly buffered and is susceptible to acidification. Concentrations of dissolved manganese, chloride, and iron exceeded State drinking water standards at 16, 2, and 2 sites, respectively. Maximum reported concentrations of these constituents were 1,400 microg/L, 1,100 mg/L, and 370 microg/L, respectively. (Author's abstract)
W91-04642

ESTIMATION OF THE RELATIVE PERMEABILITY DISTRIBUTION IN FRACTURED GRANITIC ROCKS BY MEANS OF VERTICAL FLOW MEASUREMENTS IN THE SIBLINGEN BOREHOLE, SWITZERLAND.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7B.
W91-04643

GEOHYDROLOGY OF THE BETHPAGE-HICKSVILLE-LEVITTOWN AREA, LONG ISLAND, NEW YORK.
Geological Survey, Syosset, NY. Water Resources Div.
D. A. Smolensky, and S. M. Feldman.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 88-4135, (1988). 25p, 15 fig, 1 tab, 1 pl (in pocket), 6 ref. Prepared in cooperation with the Nassau County Department of Health.

Descriptors: *Geohydrology, *Groundwater movement, *Long Island, *Water resources data, Clays, Gravel, Groundwater budget, Groundwater level, Groundwater mining, Groundwater recharge, Groundwater resources, New York, Sand, Silt, Water use, Well yield.

A study of groundwater levels and flow in east-central Nassau County, N.Y., began in October 1985. The 11.4 sq-mile area encompasses parts of Bethpage, Hicksville, Levittown, Plainview, Plainedge, and Farmingdale. Approximately 1,200 ft of unconsolidated Cretaceous deposits and 50 to 100 ft of Pleistocene deposits overlie bedrock throughout the area. The unconsolidated deposits consist mostly of sand, gravel, silt, and clay and have good water-transmitting properties except where clay forms continuous layers that can impede groundwater flow. The area is mostly residential and industrial. Pumpage for public supply exceeds 10 million gal/day, most of which eventually discharges from the groundwater system to tidewater as sewage outflow. Industrial pumpage during summer exceeds 10 million gal/day, but most of the water is returned to the system through recharge basins. Groundwater levels in this area fluctuate seasonally in response to natural recharge, pumping, and use of recharge basins. (Author's abstract)
W91-04646

GROUND-WATER QUALITY NEAR A SCAVENGER-WASTE-DISPOSAL FACILITY IN MANORVILLE, SUFFOLK COUNTY, NEW YORK, 1984-85.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04647

DISTRIBUTION AND ACTIVITY OF BACTERIA IN DEEP GRANITIC GROUNDWATERS OF SOUTHEASTERN SWEDEN.
Goeteborg Univ. (Sweden). Dept. of Marine Microbiology.
K. Pedersen, and S. Ekendahl.
Microbial Ecology MCBEBU, Vol. 20, No. 1, p 37-52, July/August 1990. 5 tab, 44 ref.

Descriptors: *Aquatic bacteria, *Bacteria, *Groundwater, *Microbial transport, *Microbiological studies, *Sweden, Anaerobic bacteria, Bacterial analysis, Bedrock, Biofilms, Boreholes, Culturing techniques, Granites, Spatial distribution.

The distribution of bacteria in groundwater was investigated at 16 different levels in five boreholes in granite bedrock down to a maximum of 860 m. Enrichment cultures were used to assay the groups of bacteria present. Autoradiographic studies with C14-labeled or H3-labeled formate, methanol, acetate, lactate, glucose, sodium bicarbonate, leucine, glutamine, thymidine, or N-acetyl-glucosamine were used to obtain information about bacteria active in substrate uptake. The biofilm formation potential was studied in one borehole. The chemical environment in the groundwater was anaerobic with an Eh between -112 and -383 mV, a pH usually around 8, and a temperature range of 10.2 to 20.5 C, depending on the depth. The organic content ranged between <0.5 and 9.5 mg total organic carbon/L. Carbon dioxide, hydrogen, hydrogen sulfide, and methane were present in the water. The nitrate, nitrite, and phosphate concentrations were close to, or below, the detection limits, while there were detectable amounts of NH4(+) in the range of 4 to 330 micrograms/L. The average total number of bacteria was 260,000 bacteria/ml, as determined with an acridine orange direct-count (AODC) technique. The average number of bacteria that grew on a medium with 1.5 g/L of organic substrate was 7,700 colony-forming units (CFU)/ml. The majority of these were facultatively anaerobic, gram-negative, nonfermenting heterotrophs. Enrichment cultures indicated the presence of anaerobic bacteria capable of growth on C-1 compounds and hydrogen, presumably methanogenic bacteria. Most probable

number assays with sulfate and lactate revealed up to 56,000 viable sulfate-reducing bacteria/ml. A biofilm development experiment indicated an active attached microbial population. Active substrate uptake could not be registered with the bulk water populations, except for an uptake of leucine not associated with growth. The bulk water microbial cells in deep groundwater may be inactive cells detached from active biofilms on the rock surface. (Author's abstract)
W91-04725

BIOLOGICAL TRANSFORMATIONS OF 1,1,1-TRICHLOROETHANE IN SUBSURFACE SOILS AND GROUND WATER.
Dow Chemical Co., Midland, MI. Health and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-04743

EVALUATION OF TWO MODELS DESCRIBING THE STEADY DISCHARGE FROM A CONSTANT HEAD WELL PERMEAMETER INTO UNSATURATED SOIL.
Institute for Soil Fertility, Haren (Netherlands). Dept. of Soil Physics and Root Ecology.
For primary bibliographic entry see Field 2G.
W91-04796

COMPARISON OF CAPILLARY PRESSURE-SATURATION RELATIONS FOR DRAINAGE IN TWO-AND THREE-FLUID POROUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
L. A. Ferrand, P. C. D. Milly, G. F. Pinder, and R. P. Turrin.
Advances in Water Resources AWREDI, Vol. 13, No. 2, p 54-63, 1990. 11 fig, 1 tab, 48 ref. DOE grant DE-ACO2-83ER60170 and NSF grant ECE-8501649.

Descriptors: *Fluid mechanics, *Groundwater movement, *Groundwater pollution, *Model studies, *Path of pollutants, *Porous media, Capillarity, Chlorinated hydrocarbons, Pressure, Saturation, Transport models.

Two-fluid and three-fluid capillary pressure-saturation data were generated for porous media consisting of unconsolidated quartz sand, air, tetrachloroethylene (PCE), and water. The use of Leverett Scaling of two-fluid data to predict the capillary pressure-saturation (Pc-S) relation for arbitrary fluid pairs in a given medium was tested using the two-fluid data. The use of surface tensions reported for pure liquids in the scaling was found to give poor agreement between predicted and measured results for air-water, air-PCE and PCE-water curves. However, an alternate scaling which forced the curves to coincide on average gave good agreement, except near residual saturations. A lack of multiphase constitutive data for the three-phase case is frequently cited by both petroleum reservoir modelers and groundwater contaminant transport modelers as a primary hindrance to effective forecasting. Therefore, methods for extrapolating three-fluid relationships from two-fluid data were developed and used with little experimental verification. The two-fluid and three-fluid data generated in this research enabled the direct testing of a pair of three-fluid approximations for the strict drainage case. The approximations were found to be good over most of the range of saturation values, but approximations near residual saturations remain questionable. However, this equivalence cannot be assumed to extend from this relatively trivial case to real world problems. The most common three-phase contamination scenario, infiltration of an organic liquid into the unsaturated soil zone, represents a hybrid of drainage and inhibition. (Author's abstract)
W91-04825

PARALLEL COMPUTING FOR SOLUTE TRANSPORT MODELS VIA ALTERNATING DIRECTION COLLOCATION.
Wyoming Univ., Laramie. Dept. of Mathematics.
For primary bibliographic entry see Field 5B.
W91-04826

FILL DAM LEAKAGE BY NETWORK ASSESSMENT.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W91-04828

MODEL FOR COMPACTION OF SEDIMENTARY BASINS.
Institutt for Energiteknikk, Kjeller (Norway).
M. Wangen, B. Antonsen, B. Fossum, and L. K. Alm.
Applied Mathematical Modelling AMMODL, Vol. 14, No. 10, p 506-517, 1990. 21 fig, 8 fig.

Descriptors: *Compaction, *Geohydrology, *Mathematical models, *Model studies, *Porous media, *Sedimentary basins, Case studies, Darcy velocities, Heat conductivity, Porosity, Pressure, Temperature, Two-dimensional models.

A two-dimensional model for the compaction of a geological basin was developed. For each lithology in the model the porosity was considered a function of the sediment pressure and the permeability was considered a function of the porosity. The model produces the following variables as a function of time: temperature, water pressure, excess pressure, sediment pressure, bulk pressure, porosity, and Darcy velocities. It is assumed that all compaction takes place in a vertical direction and the pores are filled only with water. The pressure and temperature equations are solved by the finite element method, the equations are expressed in the fully compacted z-coordinate, and the formulation is implicit. The main variable in the pressure equation is the excess pressure. The model was applied to three case studies; one with both vertical boundaries closed, one with one vertical boundary closed, and one with both boundaries open. In all three cases the low-permeability areas were assigned a small heat conductivity and a small heat capacity compared with permeable areas. The analysis was performed at an ocean temperature of 10 C, and a heat flux into the bottom at 0.05 W/sq m. The concept is easily adapted to three dimensions. (White-Reimer-PTT)
W91-04835

COSTS OF GROUNDWATER CONTAMINATION TO THE SOUTHINGTON WATER WORKS DEPARTMENT.
Southington Water Dept., CT.
For primary bibliographic entry see Field 5A.
W91-04845

HYDROGEOLOGY OF THE MORRISON FORMATION IN THE SAN JUAN STRUCTURAL BASIN, NEW MEXICO, COLORADO, ARIZONA AND UTAH.
Geological Survey, Albuquerque, NM. Water Resources Div.
W. L. Dam, J. M. Kernodle, G. W. Levings, and S. D. Craigg.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Atlas HA-720-J, 1990. 2p, 16 fig, 3 tab, 36 ref.

Descriptors: *Arizona, *Colorado, *Geohydrology, *Groundwater resources, *Hydrologic maps, *Morrison Formation, *New Mexico, *Regional Aquifer System Analysis, *Utah, Arsenic, Dissolved solids, Fluorides, Groundwater quality, Nitrates, Selenium, Specific conductivity, Temperature.

This report is one in a series resulting from the US Geological Survey's Regional Aquifer System Analysis (RASA) study of the San Juan structural basin that began in October 1984. The Morrison Formation is a major water-bearing unit in the regional aquifer system. The purpose of the report is to summarize information about the geohydrology of the Morrison Formation, of Late Jurassic age, in the basin. The San Juan structural basin is located in New Mexico, Colorado, Arizona, and Utah, and has an area of about 21,600 sq mi. The structural basin is about 140 mi wide and 200 mi long. The Morrison Formation, which is present throughout the San Juan structural basin, consists of five members; in ascending order they are: the Salt Wash Member, Recapture Member, Westwater Canyon Member, Brushy Basin Member, and Jackpile Sandstone Member. The geologic characteristics of the Westwater Canyon Member make it the most important hydrologic unit. The Morrison Formation is a source of water for domestic, livestock, and industrial supplies in areas where drilling depths and pumping levels are economically feasible and where water quality is suitable for most uses. Water in the Formation occurs under both water table and artesian conditions. Transmissivity, storage coefficient and hydraulic conductivity data for the Formation are: 2 to 480 sq ft/day, 0.00002 to 0.0002, and 0.025 to 0.39 ft/day, respectively. The temperature of the groundwater is extremely variable, ranging from 6.0 to 48.0 C. Concentrations of fluoride generally were small; 3 of 50 samples contained fluoride at a concentration $>$ 4 mg/L. The concentration of nitrate, as nitrogen, was $<$ 10 mg/L. The concentration of arsenic in 5 of 19 samples exceeded the standard of 0.05 mg/L; the selenium in 1 of 17 samples exceeded the standard of 0.01 mg/L. The concentration of dissolved solids generally increases from near the outcrop areas toward the center of the basin. Ions contributing to the concentration of dissolved solids predominantly are sodium, sulfate and bicarbonate. (Lantz-PTT)
W91-04853

HYDROLOGIC FRAMEWORK OF LONG ISLAND, NEW YORK.
Geological Survey, Syosset, NY. Water Resources Div.
D. A. Smolensky, H. T. Buxton, and P. K. Shernoff.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Atlas HA-709, 1989. 3p, 9 fig, 1 tab, 7 maps, 50 ref.

Descriptors: *Aquifer systems, *Geohydrology, *Groundwater movement, *Groundwater resources, *Hydrologic maps, *Long Island, *Maps, *New York, Aquifers, Flow profiles, Groundwater budget, Paleohydrology.

Long Island, NY, is underlain by a mass of unconsolidated geologic deposits of clay, silt, sand, and gravel that overlie southward-sloping consolidated bedrock. These deposits are thinnest in northern Queens County (northwestern Long Island), where bedrock crops out, and increase to a maximum thickness of 2,000 ft in southeastern Long Island. This sequence of unconsolidated deposits consists of several distinct geologic units ranging in age from late Cretaceous through Pleistocene, with some recent deposits near shores and streams. These units are differentiated, in tabular form, by age, depositional environment, and lithology. The set of maps and vertical sections depicts the geohydrologic framework of the unconsolidated deposits that form Long Island's groundwater system. These deposits can be classified into eight major geohydrologic units. The geohydrologic interpretations are not everywhere consistent with strict geologic interpretation owing to facies changes and local variations in the water transmitting properties within geologic units. These maps depict the upper-surface altitude of seven of the eight geohydrologic units, which, in ascending order, are: consolidated bedrock, Lloyd aquifer, Raritan confining unit, Magothy aquifer, Monmouth greensand, Jameco aquifer, and Gardiners clay. The upper glacial aquifer--the uppermost unit--is at land surface over most of Long Island and is, therefore, not included. Nine north-south geohydrologic sections depict the entire sequence of unconsolidated deposits and, together with the maps, provide a detailed three-dimensional interpretation of Long Island's geohydrologic framework. A structure-contour map that shows the upper-surface altitude of the Cretaceous deposits is included to illustrate the erosional unconformity between the Cretaceous and overlying Pleistocene deposits. Pleistocene erosion played a major role in determining the shape and extent of the Lloyd aquifer, the Raritan confining unit, and the Magothy aquifer. (Lantz-PTT)

W91-04854

RECONNAISSANCE STUDY OF THE THICKNESS OF THE UNSATURATED ZONE IN THE WESTERN CONTERMINOUS UNITED STATES.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5E.
W91-04855

SURFACE- AND GROUND-WATER INTERACTION AND HYDROLOGIC BUDGET OF THE MISSOURI RIVER VALLEY AQUIFER BETWEEN YANKTON SOUTH DAKOTA, AND ST. LOUIS, MISSOURI.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 2A.
W91-04856

GROUND-WATER LEVELS IN THE ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1988.
Geological Survey, Little Rock, AR. Water Resources Div.
P. W. Westerfield, and C. R. Baxter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-383, September 1990. 35p, 2 fig, 1 tab, 17 ref. USGS Open-File Report 90-383, September 1990. 35p, 2 fig, 1 tab, 17 ref.

Descriptors: *Alluvial aquifers, *Arkansas, *Groundwater level, *Groundwater resources, *Mississippi, *Water resources data, Mississippi Alluvial Plain, Wells.

This report, prepared by the U.S. Geological Survey in cooperation with the Arkansas Soil and Water Conservation Commission, the U.S. Soil Conservation Service, and local Conservation Districts, contains groundwater level measurements of 509 wells that tap the alluvial aquifer in the Quaternary deposits of the Mississippi Alluvial Plain. The measurements were made by district Soil Conservation Service personnel during 1988. The shallowest prepumping season water levels occurred in Ashley, Clay, Greene, Mississippi, Phillips, and Randolph Counties where water levels averaged less than 20 ft below the land surface. The deepest water levels occurred in Arkansas, Lonoke, Poinsett, and Prairie Counties where water levels of more than 100 ft below land surface were measured. Water levels in the postpumping season averaged about 4.1 ft lower than during the prepumping season. (USGS)
W91-04863

RECORDS OF WELLS AND CHEMICAL ANALYSES OF GROUND WATER IN DEUEL AND HAMLIN COUNTIES, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04865

GROUND-WATER RESOURCES OF SELECTED HIGH VOLCANIC ISLANDS OF TRUK WITH EMPHASIS ON SMALL VILLAGE SUPPLIES.
Geological Survey, Honolulu, HI. Water Resources Div.
K. J. Takasaki.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4163, 1989. 60p, 22 fig, 6 tab, 13 ref. Project No. HI812.

Descriptors: *Groundwater availability, *Groundwater resources, *Hydrologic data, *Truk, *Water resources data, Climatic data, Data collections, Volcanoes.

Existing water supply sources in the Truk State were assessed. The first part of the assessment includes the high islands in the Truk Lagoon and the second part includes the principal inhabited outer islands of the Truk State. The high islands in the lagoons are remnant peaks of a partly sunken volcano. Coral atolls form the periphery of the lagoon. The islands are composed of tight, massive lavas and cemented rock fragments. Although saturated, the rocks yield little water to springs or wells. Weathering causes some increase in permeability, and where the weathering is the deepest as in valleys, these materials make up the main reservoirs of groundwater. Rainfall averages about 140 inches/yr and is sufficiently persistent to provide water for drinking and cooking from small rain catchments, springs and seeps with little or no storage. This situation is not desirable because rainless periods, even short ones, cause springs, seeps, and rain barrels to go dry quickly. (USGS)
W91-04866

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1989.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04869

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1990.
Geological Survey, Salt Lake City, UT. Water Resources Div.
L. R. Herbert.
Available from Utah Department of Natural Resources, 1636 West North Temple, Salt Lake City, Utah 84116. Utah Division of Water Resources Cooperative Investigations Report No. 30, 1990. 84p, 44 fig, 3 tab, 4 ref.

Descriptors: *Data collections, *Groundwater resources, *Utah, Water level, Water quality, Water use.

Information is compiled for Utah, Spring 1990, on well construction, groundwater withdrawals from wells, water level changes, and related changes in precipitation and streamflow. Supplementary data such as graphs showing chemical quality of water and maps showing water level contours are included in reports of this series only for those years or areas for which applicable data are available and are important to a discussion of changing groundwater conditions. The report includes individual discussion of selected major areas of groundwater development in the State for the calendar year 1989. Water level fluctuations, however, are described for the spring of 1989 to the spring of 1990. Much of the data used in the report were collected by the Geological Survey in cooperation with the Division of Water Rights, Utah Department of Natural Resources. (USGS)
W91-04870

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1989.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04877

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1989, VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04878

SALT-DOME LOCATIONS IN THE GULF COASTAL PLAIN, SOUTH-CENTRAL UNITED STATES.
Geological Survey, Austin, TX. Water Resources Div.
J. D. Beckman, and A. K. Williamson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4060, 1990. 44p, 14 fig, 2 tab, 18 ref.

Descriptors: *Aquifers, *Geological formations, *Gulf of Mexico, *Gulf of Mexico Coastal Plain, *Regional Aquifer System Analysis, *Salt domes, Data collections, Stratigraphy.

Information on salt domes in Gulf of Mexico Coastal Plain, south-central United States and the adjacent Continental Shelf were compiled from major published sources, 1973-84. The location of 624 salt domes is shown on a map at a scale of 1:1,500,000. A color-coding system was used to show that the occurrence, size, shape, and location of these domes varies among sources. Two tables of additional data accompany the map and include other available information such as: identifying sources, depth to salt and caprock, diameter, volume, name, and uppermost zone of surrounding sediment that is penetrated, as well as the number of matches between sources. The locations of salt domes that penetrate specific zones within the gulf coast regional aquifer system are shown on maps. (USGS)
W91-04880

WATER RESOURCES OF THE DESCANSO AREA, SAN DIEGO COUNTY, CALIFORNIA.
Geological Survey, San Diego, CA. Water Resources Div.
L. F. W. Duell.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4014, 1990. 26p, 15 fig, 7 tab, 19 ref.

Descriptors: *California, *Groundwater availability, *Groundwater resources, *Water quality, *Water yield, Geohydrology, Pumpage, Recharge, San Diego County, Storage, Water use.

Hydrologic information was collected during water year 1988 (October 1987 to September 1988) to evaluate the effects of current pumping on groundwater levels in the Descanso area in south-central San Diego County. Water year 1988 was a period of near-normal precipitation and runoff. The groundwater system in the area consists of aquifers in the metamorphic and granitic bedrock and in the overlying regolith (weathered bedrock). Most wells penetrate both aquifers, but the regolith is the source of most water pumped from wells. Groundwater storage in 1988 was estimated to be 800 to 2,000 acre-ft in the regolith and 300 to 3,000 acre-ft in bedrock. Recharge to the groundwater system from infiltration of precipitation and streamflow was estimated to be about 1,000 acre-ft. Pumpage, which was estimated to be 170 acre-ft, had little effect on groundwater storage. Water levels in wells were nearly the same at the end of the water year as at the beginning. Groundwater quality generally was suitable for domestic uses. Concentrations of iron and manganese, although nontoxic, exceeded California maximum contaminant levels for domestic drinking water in some wells. (USGS)
W91-04882

GEOHYDROLOGY, WATER QUALITY, AND WATER BUDGETS OF GOLDEN GATE PARK AND THE LAKE MERCED AREA IN THE WESTERN PART OF SAN FRANCISCO, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
E. B. Yates, S. N. Hamlin, and L. H. McCann.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4080, 1990. 45p, 6 fig, 1 pl, 9 tab, 61 ref.

Descriptors: *California, *Geohydrology, *Hydrologic budget, *Lake Merced, *Water quality, *Water resources, Groundwater, Nitrates, San Francisco, Stable isotopes, Water level.

The groundwater resources in the western part of the San Francisco, groundwater budgets for Golden Gate Park and the Lake Merced area, and a surface-water budget for Lake Merced are described. A continuous groundwater basin underlies a 39-sq-mi coastal strip in the San Francisco Peninsula south of the city. Basin fill consists largely of sand and silt. An extensive subsurface clay layer is

present near Lake Merced. Recharge is principally from rainfall and irrigation-return flow, with lesser amounts from leaking water and sewer pipes, which were identified in part by stable-isotope and major ion analyses. In Golden Gate Park, about 1,070 acre-ft/yr of groundwater flows to the ocean. Water levels are not declining, and pumpage could be safely increased. However, nitrate concentrations in excess of Federal drinking-water standards in water from many wells may limit potential uses of groundwater. Groundwater in the Lake Merced area is in a state of overdraft, as indicated by long-term declines in the level of Lake Merced and by groundwater levels persistently below sea level in deep wells. Seawater intrusion has not been detected, however. A surface-water budget for Lake Merced indicates that the largest inflow is from shallow groundwater and the largest outflow is loss by evaporation. (USGS)
W91-04883

DIGITAL SIMULATION OF THE GLACIAL-AQUIFER SYSTEM IN THE NORTHERN THREE-FOURTHS OF BROWN COUNTY, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
P. J. Emmons.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4198, 1990. 74p, 31 fig, 10 tab.

Descriptors: *Aquifers, *Groundwater movement, *Model studies, *South Dakota, Geohydrology, Groundwater, Groundwater models, Simulation.

A digital model was developed to simulate groundwater flow in a complex glacial-aquifer system that includes the Elm, Middle James, and Deep James aquifers in South Dakota. The average thickness of the aquifers ranges from 16 to 32 ft and the average hydraulic conductivity ranges from 240 to 300 ft/day. The maximum steady-state recharge to the aquifer system was estimated to be 7.0 in./yr, and the maximum potential steady-state evapotranspiration was estimated to be 35.4 in/yr. Maximum monthly recharge for 1985 ranged from zero in the winter to 2.5 in in May. The potential monthly evapotranspiration for 1985 ranged from zero in the winter to 7.0 in in July. The average difference between the simulated and observed water levels from steady-state conditions (pre-1983) was 0.78 ft and the average absolute difference was 4.59 ft for aquifer layer 1 (the Elm aquifer) from 22 observation wells and 3.49 ft and 5.10 ft, respectively, for aquifer layer 2 (the Middle James aquifer) from 13 observation wells. The average difference between the simulated and observed water levels from simulated monthly potentiometric heads for 1985 in aquifer layer 1 ranged from -2.54 ft in July to 0.59 ft in May and in aquifer layer 2 ranged from -1.22 ft in April to 4.98 ft in November. Sensitivity analysis of the steady-state model indicates that it is most sensitive to changes in recharge and least sensitive to changes in hydraulic conductivity. (USGS)
W91-04884

EFFECTS OF FOLIATION ON THE HYDROLOGIC PROPERTIES OF PIEDMONT SAPROLITE.
Clemson Univ., SC. Dept. of Forestry.
R. K. White, and W. R. Fleck.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274143/AS. Price codes: A05 in paper copy, A01 in microfiche. South Carolina Water Resources Research Institute, Clemson University, S.C., Publication No. 130, May 1990. 89p, 20 fig, 33 tab, 60 ref. 2 append. USGS Contract No. 14-08-0001-G1588. USGS Project No. G1588-05.

Descriptors: *Foliation, *Groundwater, *Hydraulic conductivity, *Saprolite, Computer models, Hydrologic properties, Hydrology, Mineralogy, Permeability, Piedmont Region, Saturated flow, Soil moisture, Unsaturated flow, Watershed data.

Undisturbed core samples were taken from two exposed granite gneiss saprolite profiles located on and adjacent to Clemson University Research Watershed. One profile displayed a distinct remnant foliation with broad continuous banding and the other displayed little or no remnant foliation. Each profile was sampled in equal increments to depths of 3 to 6 m. Samples were taken parallel and perpendicular to the remnant foliation profile and vertically and horizontally for the nonfoliated profile. Samples were taken using a 'slip-tube' sampler. The saturated hydraulic conductivity (K) and soil moisture-tension curve (H(O)) were measured for each sample. Theoretical unsaturated hydraulic conductivity curves (K(O)) were derived using a computer model called SOIL. Changes in mineralogy with depth were noted based on x-ray diffraction and dry bulk density determination. Results indicated that the remnant foliation had a weak effect on the hydrologic properties of the foliated saprolite. As suspected, water moved more rapidly parallel to the foliation. The nonfoliated profile data displayed a small, but consistent difference between vertical and horizontal hydrologic properties with the horizontal properties favoring more rapid water movement. However, statistical analysis failed to prove any significant difference between the vertical and horizontal properties. The dry bulk density of the samples stayed fairly consistent with depth for both profiles. Visual and x-ray analyses showed the typical mineralogic heterogeneities with depth commonly associated with Piedmont saprolite in the foliated profile. However, the nonfoliated profile showed little mineralogic deviation with depth. (White-WRRI)
W91-04885

GROUND-WATER PUMPAGE AND WATER-LEVEL DECLINES IN THE PEEDEE AND BLACK CREEK AQUIFERS IN ONSLOW AND JONES COUNTIES, NORTH CAROLINA, 1900-86.
Geological Survey, Raleigh, NC. Water Resources Div.
W. L. Lyke, and A. R. Brockman.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 89-4197, 1990. 32p, 8 fig, 2 tab, 10 ref.

Descriptors: *Confined aquifers, *North Carolina, *Pumpage, *Water level, Black Creek Aquifer, Coastal plains, Peedee Aquifer.

Two aquifers in sediments of Cretaceous age, The Peedee and Black Creek aquifers, have become a major source of freshwater in Onslow and Jones Counties in North Carolina since about 1960. Prior to 1960, most water systems in this area withdrew water from younger sand or limestone beds that overlie the Peedee and Black Creek aquifers. Water-quality and economic considerations related to the treatment of water from these shallower aquifers led to increased use of the Peedee and Black Creek aquifers. Water withdrawals from the Black Creek and Peedee aquifers were about 10,000 gal/day in 1933. By 1986, total withdrawals were about 7.8 million gal/day, about 90% of which was supplied from the Black Creek aquifer. As a result of these withdrawals, groundwater levels have declined throughout Onslow and Jones Counties. The average rate of decline in static water levels in the Peedee aquifer is about 0.6 ft/year in central Jones County and about 1.4 ft/year in northern Onslow County. Rates of water level decline in the Black Creek aquifer average about 8.3 ft/year in Jones County to about 12 ft/year in northern Onslow County. Water levels in the Peedee aquifer have declined as much as 40 ft in Jones County and 80 ft in northern Onslow County since about 1900. During the same period, water levels in the Black Creek aquifer have declined as much as 120 and 160 ft in Jones and northern Onslow Counties, respectively. (Author's abstract)
W91-04901

CONTINUOUS SEISMIC REFLECTION PROFILING OF HYDROGEOLOGIC FEATURES BENEATH NEW RIVER, CAMP LEJEUNE, NORTH CAROLINA.
Geological Survey, Raleigh, NC. Water Resources Div.
A. P. Cardinell, D. A. Harned, and S. A. Berg.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 89-4195, 1990. 33p, 13 fig, 1 tab, 10 ref.

Descriptors: *Geohydrology, *Geology, *Geophysical exploration, *Geophysics, *North Carolina, *Seismic exploration, Camp Lejeune, New River Estuary.

A medium-power, wide-frequency seismic system was used to collect more than 100 miles of continuous seismic reflection profiling data over a 4-day period along a 24-mile segment of the New River estuary and Intracoastal Waterway. The seismic reflection data were evaluated to determine the continuity of aquifer sediments and correlation with existing borehole geophysical well-log data at the Base. Results indicate that the Castle Hayne aquifer, the major source of freshwater for the military base and surrounding area, and deeper aquifers are continuous beds that gently dip to the southeast. However, immediately above the Castle Hayne aquifer, the survey showed that sediment beds are thin and discontinuous. This not only allows rainfall to more easily percolate and recharge the aquifer, but also makes the Castle Hayne more vulnerable to contamination. (USGS)
W91-04902

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1989. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04903

WATER RESOURCES DATA ARIZONA, WATER YEAR 1989.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W91-04904

ANALYSIS OF SATURATED HYDRAULIC CONDUCTIVITY IN A FORESTED GLACIAL TILL SLOPE.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
B. Espeby.
Soil Science SOSCAK, Vol. 150, No. 2, p 485-494, 1990. 6 fig, 6 tab, 22 ref.

Descriptors: *Forest hydrology, *Glacial soils, *Groundwater movement, *Hydraulic conductivity, *Saturated flow, *Slopes, *Soil density, *Soil water, *Sweden, Correlation analysis, Forests, Grain size, Homogeneity, Permeability, Saturation, Soil depth, Spatial distribution, Statistical analysis.

A statistical analysis was made of 100 soil core samples taken from six soil pits in a forested glacial till slope in south central Sweden to determine the spatial variability of the saturated hydraulic conductivity, K, and correlations to other soil properties. The highest correlation of K, 0.77, was established with drainable porosity. The correlation of K with total porosity and bulk density were lower, 0.64 and -0.62, respectively. However, correlations of K with all of these properties increased with depth. Even though the correlation coefficients are moderate, the relationship between K and drainable porosity provides a quick method of estimating the relative permeabilities when only the drainable porosities are known. Sample groups of different core lengths (50 and 100 mm long) could not be distinguished statistically, and therefore the main analysis included all K values irrespective of core length. A two ANOVAs (one using each pit as a sample group) indicated the K values differed significantly with soil depth, with a strong decreasing trend with increasing depth. By excluding the samples from one sample group from the ANOVA analysis, however, statistical significance was obtained for five pits (homogenous conditions concerning the saturated hydraulic conductivity in the

slope). For the interaction effect between pit locations and horizon level on the K values, a MANOVA showed no significant difference at a 95% confidence limit. A multiple range test with a 95% confidence limit, however, separated the different pits into four different categories based on the average K values. These categories followed the natural siting of the pit locations, with high K values found in the middle region of the glacial till slope. The multiple range analysis also separated the different horizons into three categories, with the highest conductivities in a coarse-textured, wave-washed horizon. (Author's abstract)
W91-04909

FINITE HYDRAULIC CONDUCTIVITY EFFECTS ON OPTIMAL GROUNDWATER PUMPING RATES.
Mission Research Corp., Albuquerque, NM.
For primary bibliographic entry see Field 6D.
W91-04914

SERIES REPRESENTATION OF FLUX FOR THE BOUSSINESQ EQUATION.
Thessaloniki Univ., Salonika (Greece). Faculty of Engineering.
P. Tolikas, A. Damaskinidou, and E. Sidripoulos.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2881-2886, December 1990. 2 tab, 17 ref.

Descriptors: *Boussinesq equation, *Fluctuations, *Groundwater, *Groundwater movement, *Hydrologic models, *Mathematical models, *Model studies, Accuracy, Boundary conditions, Differential equations, Hydraulic profiles.

The Boussinesq equation, supplemented with Dirichlet-type boundary conditions, is used to describe one-dimensional groundwater flow. After a number of transformations a nonlinear ordinary differential equation is obtained with flux as the dependent variable. Through perturbation the slope of the water profile at the origin is expressed in the form of a rapidly converging series and can, therefore, be calculated to the desired accuracy. Thus, the corresponding two-point boundary problem is solved without iteration. Also, quantities related to physical aspects of the problem are easily calculated. Furthermore, the same treatment is directly applicable to a number of other physical and engineering situations governed by the same equation. (Author's abstract)
W91-04916

ERROR ANALYSIS AND STOCHASTIC DIFFERENTIABILITY IN SUBSURFACE FLOW MODELING.
California Univ., Santa Barbara. Dept. of Geography.
H. A. Loaiciga, and M. A. Marino.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2897-2902, December 1990. 1 fig, 19 ref, append. University of California Water Resources Center Project UCAL-WRC-W-697.

Descriptors: *Error analysis, *Fluid mechanics, *Groundwater movement, *Hydrologic models, *Model studies, *Steady flow, *Stochastic models, Analysis of variance, Differential equations, Hydraulic conductivity, Piezometric potential, Standard deviation, Stochastic flow.

In the stochastic analysis of steady aquifer flow, the log hydraulic conductivity (LHC) is the random input and the piezometric potential (PP) is the random output. Their joint behavior is governed by a differential equation that, in view of the random nature of its dependent and independent variables, represents a stochastic differential equation. The analysis of the distributional properties of the piezometric potential field involves the product of the gradients of LHC and of the PP. A closed-form expression was derived for the standard deviation, and hence the order of magnitude, of the product of the random gradients of LHC and of PP. For statistically homogeneous LHC fields (1) the product of the random gradients may or may not have a zero mean, depending on whether the specific discharge is a constant or a random quantity, respectively; (2) under joint normality of the LHC and the PP fields, their random gradients are statistically independent if the specific discharge is constant but are dependent when the specific discharge is random; (3) the standard deviation of the product of random gradients is proportional to the variance of LHC times a term involving three quantities: the covariance of the PP, the covariance of the LHC, and the cross covariance of the latter two fields; (4) a necessary and sufficient condition for the smallness of the product of random gradients is that the second derivatives of the covariance of the LHC, the covariance of the PP, and the cross covariance of the latter two random fields be finite and that the variance of the LHC be much less than one. The role of Gaussian distributional assumptions is highlighted in the derivation of key results of stochastic groundwater flow via perturbation analysis. (Author's abstract)
W91-04918

SYSTEMATIZED DRILLSTEM TEST.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
K. Karasaki.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2913-2919, December 1990. 9 fig, 2 tab, 24 ref. US Dept of Energy contract No. DE-AC03-76F00098.

Descriptors: *Analytical methods, *Aquifer characteristics, *Aquifer testing, *Drillstem tests, *Pumping tests, Data analysis, Field tests, Parameter estimation, Permeability, Pressure, Slug tests.

A drillstem test (DST) allows better estimation of the flow parameters from slug tests when skin is present. Furthermore, the duration of the test can be shortened by up to an order of magnitude compared to a slug test carried all the way to the stabilization. A systematized procedure of a DST is proposed, in which a slug test is terminated in the midpoint of the flow period, and the subsequent shut-in data are recorded and analyzed. This method requires a downhole shut-in device and a pressure transducer, which is no more than the conventional deep-well slug testing. More accurate estimates of formation permeability can be made using a DST than a slug test. Premature termination also shortens the test duration considerably. Based on these results, conventional slug tests could be replaced by the premature termination technique. (Author's abstract)
W91-04920

2G. Water In Soils

X-BAND SCATTEROMETRY IN AGRICULTURE.
Budapesti Mueszaki Egyetem (Hungary). Dept. of Microwave Telecommunications.
For primary bibliographic entry see Field 7B.
W91-03945

ASSESSMENT OF ATM AND SATELLITE DATA FOR ESTIMATING THE GROUNDWATER CONTRIBUTION TO SLOPE STABILITY.
University Coll., Cardiff (Wales). Dept. of Civil and Structural Engineering.
For primary bibliographic entry see Field 7B.
W91-03958

SIMULATING TEST FOR SOIL MOISTURE SENSING.
China Research Inst. of Radiowave Propagation, Xinxiang.
For primary bibliographic entry see Field 7B.
W91-03961

MICROWAVE X-BAND RADIOMETRIC CHARACTERIZATION OF BRAZILIAN SOILS BY MEASUREMENT OF THE COMPLEX PERMITTIVITY.
Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
For primary bibliographic entry see Field 7B.
W91-03962

MICROCOMPUTER-BASED RADIOMETER DATA ACQUISITION AND PROCESSING SYSTEM FOR LARGE-AREA MAPPING OF SOIL MOISTURE CONTENT IN THE TOP ONE METER LAYER.
Akademiya Nauk SSSR, Moscow. Inst. Radiotekhniki i Elektroniki.
For primary bibliographic entry see Field 7B.
W91-03963

OBSERVATIONS ON THE EFFECT OF GEOMETRIC PROPERTIES OF AGRICULTURAL SOILS ON RADAR BACKSCATTER, FROM C-SAR IMAGES.
Sherbrooke Univ. (Quebec). Centre d'Applications et de Recherches en Teledetection.
For primary bibliographic entry see Field 7B.
W91-03965

DISSOLUTION OF FELDSPARS IN THE PRESENCE OF NATURAL, ORGANIC SOLUTES.
Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.
For primary bibliographic entry see Field 2J.
W91-03986

IMPROVED PREDICTION OF WATER-RETENTION PROPERTIES OF CLAYEY SOILS BY PEDOLOGICAL STRATIFICATION.
Service d'Etude des Sols et de la Carte Pedologiue de France, Olivet.
A. Bruand.
Journal of Soil Science JSSCAH, Vol. 41, No. 3, p 491-497, September 1990. 5 tab, 26 ref.

Descriptors: *Clays, *Soil absorption capacity, *Soil profiles, *Soil water, Density, Matric potential, Seasonal variation, Soil horizons, Stratification, Wetting.

The water retention properties of clayey soils have been studied at -30,000 and -150,000 Pa matric potentials using three sets of clayey horizons differing in their pedological origin. Measurements were made on small clods collected in winter when swelling is at a maximum. Variations in the clay content and clay fabric, via bulk volume, allow the variation in water retained to be explained better than with clay content alone. With clayey horizons originating from a single soil family, differences in water retained can be explained by variations in clay content alone because clay fabric does not change greatly. These results demonstrate the significance of pedological stratification in estimating the water-retention properties when a single soil characteristic, such as clay content, is used. Without pedological stratification, an equation of the water-retention curve could be established using the less easily obtained variable, bulk volume. (Author's abstract)
W91-03987

SOIL ORGANIC MATTER, AIR ENCAPSULATION AND WATER-STABLE AGGREGATION.
Sydney Univ. (Australia). Dept. of Soil Science.
L. A. Sullivan.
Journal of Soil Science JSSCAH, Vol. 41, No. 3, p 529-534, September 1990. 2 fig, 2 tab, 30 ref.

Descriptors: *Organic matter, *Reviews, *Soil chemistry, *Soil water, Hydrophobic compounds, Soil aggregates, Soil management, Soil porosity.

Many of the world's cultivated soils contain unstable aggregates which break down when wetted rapidly. This structural instability often reduces crop yields and increases soil erosion. A re-interpretation of published data shows that first, the hydrophobic properties of soil organic matter can increase the amount of air encapsulation within soil materials during water uptake; and second, that this increased air encapsulation can reduce water uptake rates sufficiently to prevent slaking. This aggregate stabilizing mechanism suggests novel approaches to soil management, based on the production of non-uniformly distributed hydrophobic organic matter within intra-aggregate pores, that

could be used to improve soils whose aggregates fail when wetted rapidly. (Author's abstract)
W91-03988

EXPERIMENTAL STUDY OF NON-UNIFORM FLOW IN GRANULAR POROUS MEDIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
S. E. Van Der Zee.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 227-240, October 1990. 6 fig, 33 ref.

Descriptors: *Dispersion, *Groundwater movement, *Path of pollutants, *Porous media, *Soil contamination, *Soil water, Hydrodynamics, Laboratory methods, Mathematical models, Nonuniform flow, Viscosity.

Contaminant transport in soil is usually modeled by solving the convection-dispersion or related equations. Due to viscosity differences between the resident fluid and the injected fluid, displacement may become unstable. A threshold velocity can be defined, above which viscous fingering may occur. This threshold velocity does not take the effects of dispersion and mass transfer from microporous solids into account. Stabilizing effects due to gravity, a gradual change in viscosity, and mass transfer from the grains towards the macropore system were insufficient to prevent viscous fingering. Experiments show that the stabilizing effect of an exponentially decreasing viscosity is not sufficient to prevent viscous fingering. Also in the case of mass transfer from microporous grains to the macropores of the coarse-grained medium significant instability was found. (Author's abstract)
W91-04029

RAPID METHANE OXIDATION IN A LANDFILL COVER SOIL.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5E.
W91-04065

KINETIC MODEL FOR BIOCONCENTRATION OF LIPOPHILIC COMPOUNDS BY OLIGOCHAETES.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 5B.
W91-04076

USE OF PRACTICAL ASPECTS OF SOIL BEHAVIOUR TO EVALUATE DIFFERENT METHODS TO GENERATE SOIL HYDRAULIC FUNCTIONS.
Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen (Netherlands).
J. H. M. Wosten, C. H. J. E. Schuren, J. Bouma, and A. Stein.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 299-310, October/December 1990. 6 fig, 3 tab, 25 ref.

Descriptors: *Data acquisition, *Evapotranspiration, *Hydraulic properties, *Leaching, *Path of pollutants, *Soil properties, Model studies, On-site data collections, Simulation analysis, Soil profiles, Unsaturated zone.

Four different methods to generate soil hydraulic functions were evaluated in terms of their effect on calculation of two practical aspects of soil behavior: evapotranspiration deficit and flux through a plane at 30 cm depth which is relevant for studies of the migration of pesticides and fertilizers from the root zone towards the groundwater table. Method A involved direct on-site measurement. Method B used measurement in soil horizons in the area. Method C used a national data set. Method D used Van Genuchten parameters correlated with soil texture and organic matter content. Evapotranspiration deficit and flux through a plane at 30 cm depth were calculated with a validated simulation model. Calculations were made for three sites for a seven-year period from 1976 to 1982. Differences among the four methods to generate soil hydraulic functions in terms of calculated deficits and fluxes were not significant. However, methods were significantly different when rainfall deficits were used as a covariable. This is true with the exception of downward fluxes in the period October until March which are most important for leaching of pollutants. The user has to decide whether differences between methods are sufficiently large to justify repeated, expensive on-site measurements (method A) or whether an investment will be made to make standard series of curves to be used everywhere (methods C and D). (Geiger-PTT)
W91-04100

PROCESSES OF WATER MOVEMENT THROUGH A CHALK COOMBE DEPOSIT IN SOUTHEAST ENGLAND.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W91-04104

SPATIAL ANALYSIS OF VARIANCE APPLIED TO SOIL-WATER INFILTRATION.
Iowa State Univ., Ames. Dept. of Statistics.
C. A. Gotway, and N. A. C. Cressie.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2695-2703, November 1990. 8 fig, 3 tab, 21 ref. NSF Grant DMS-8703083.

Descriptors: *Infiltration, *Model studies, *Soil water, Analysis of variance, Graphical analysis, Infiltration rate, Soil porosity, Soil water potential, Spatial variation, Statistical analysis.

At any given location in the field, the ability of water to infiltrate soil depends upon the existing soil-water distribution with depth, the rate of water application to the soil surface, and the soil-pore-structure distribution with depth. As the location varies across the field, this ability will vary spatially so that locations nearby are more alike with regard to infiltration than those far apart. This spatial dependance among the infiltration measurements may be used to enhance any statistical analysis of soil water infiltration. Moreover, failure to account for spatial correlation, in general, can lead to erroneous inference procedures that could result in incorrect conclusions. A spatial analysis of variance uses the spatial dependence among the observations to modify the usual inference procedures associated with a statistical linear model. When spatial correlation is present, the usual tests for presence of treatment effects may no longer be valid, and erroneous conclusions may result from assuming that the usual F ratios are F distributed. This is demonstrated using a spatial analysis of soil water infiltration data. Emphasis is placed on modeling the spatial dependence structure with geostatistical techniques, and this spatial dependence structure is then used to test hypotheses about fixed effects using a nested linear model. (Mertz-PTT)
W91-04123

RATIONALE FOR OLD WATER DISCHARGE THROUGH MACROPORES IN A STEEP, HUMID CATCHMENT.
Utah State Univ., Logan. Watershed Science Unit.
J. J. McDonnell.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2821-2832, November 1990. 10 fig, 1 tab, 37 ref.

Descriptors: *Groundwater movement, *Headwaters, *New Zealand, *Rainfall-runoff relationships, *Runoff, *Soil water, *Storm runoff, Infiltration, Macropores, New water, Old water, Slopes, Streamflow, Tropical regions.

Progress in understanding processes of storm runoff generation in humid headwater catchments is hampered by discrepancies often found between physical, chemical, and isotopic approaches. Recent work in a highly responsive catchment at Maimai (M8) on the west coast of New Zealand has yielded conflicting results regarding the importance of new versus old water in through-flow transmission. Simultaneous observations of rapid preferential flow through macropores and isotopically old water displacement remain unresolved in the Maimai catchment. Continuous, three-dimensional soil moisture energy conditions were monitored in two discrete catchment positions for a series of storm events in 1987. Tensiometric response was related to the soil water characteristic curve, hillslope throughflow, and total catchment runoff. For events yielding <2 mm/hour peak runoff, near-stream valley bottom groundwater systems discharged water volumes sufficient to account for storm period streamflow. This process was assisted by regular low matric potential conditions and rapid filling of available soil water storage. For events yielding >2 mm/hour peak storm flow, hillslope hollow drainage into steeply sloping first-order channels dominated old water production and most of the catchment storm flow. Highly transient macropore-driven processes of crack infiltration, slope water table development, and lateral pipe flow enabled large volumes of stored water to be delivered to the first-order channel bank at the appropriate time to satisfy catchment storm flow volumes and water isotopic and chemical composition. (Mertz-PTT)
W91-04136

ENVIRONMENTAL RESEARCH FIELD SITE 'HORKHEIMER INSEL': RESEARCH PROGRAM, INSTRUMENTATION AND FIRST RESULTS.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 7A.
W91-04308

SOILWATER DISTRIBUTION IN A NONUNIFORMLY IRRIGATED FIELD WITH ROOT EXTRACTION.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 3F.
W91-04395

SOLUTIONS OF ONE-DIMENSIONAL WATER FLOW AND MASS TRANSPORT EQUATIONS IN VARIABLY SATURATED POROUS MEDIA BY THE FINITE ELEMENT METHOD.
Thessaloniki Univ., Salonika (Greece). School of Agriculture.
For primary bibliographic entry see Field 5B.
W91-04396

HILLSLOPE PARAMETER ESTIMATION USING THE INVERSE PROCEDURE.
Western Australia Univ., Nedlands. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-04405

REMOTE ESTIMATION OF SOIL MOISTURE AVAILABILITY AND FRACTIONAL VEGETATION COVER FOR AGRICULTURAL FIELDS.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
T. N. Carlson, E. M. Perry, and T. J. Schmugge.
Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 1/2, p 45-69, August 1990. 13 fig, 1 tab, 33 ref. National Aeronautics and Space Administration grant NAG 5-919; United States Geological Survey grant no. 14-08-0001-G1490; United States Department of Agriculture/Agricultural Research Service grant no. 58-32U4-8-27.

Descriptors: *Agricultural hydrology, *Cultivated lands, *Moisture availability, *Radiometry, *Remote sensing, *Soil surfaces, *Soil water, *Soil-water-plant relationships, Analysis of variance, Boundary layers, Canopy, Estimating, France, Leaves, Radiation, Root zone, Surface water, Temperature effects, Vegetation effects.

Models for estimating the surface turbulent energy fluxes and the soil moisture generally depend on a sensitivity of the surface radiometric temperature to soil water content. A method has been developed for using remote measurements to estimate vegetation fraction, surface energy fluxes and the root zone and soil surface water contents for partial vegetation canopies. The primary tools are a

boundary layer model with vegetation and substrate components and two image products: the variation of surface radiometric temperature vs. normalized difference vegetation index (NDVI), and the standard deviation of radiometric surface temperature vs. radiometric surface temperature. The method is based on determining: (1) asymptotic values of two radiometric surface temperatures for sunlit bare soil and for dense sunlit vegetation; and (2) a relationship between NDVI and surface temperature, called the axis of variation. From this, average soil moisture values for surface and root zone are obtained, as well as a vegetation fraction, surface turbulent heat fluxes, and leaf area index as functions of NDVI for each pixel. The method was tested using aircraft and surface measurements from Lubbon, France. It is found that the two image diagrams yield useful qualitative distribution of vegetation cover, small-scale variations in soil moisture, and vertical gradient of soil water content. A reliable axis of variation could be determined by making composite measurements obtained from a sequence of images, although it is still too early to determine if lower-resolution satellite radiometers can define a usable axis of variation. (Fish-PTT)
W91-04491

EFFECT OF TILLAGE ON SOIL WATER AND ALFALFA ESTABLISHMENT IN CORN STUBBLE.
For primary bibliographic entry see Field 3F.
W91-04537

LONG-TERM SOIL MOISTURE STATUS IN SOUTHERN ALBERTA.
Agriculture Canada, Lethbridge (Alberta). Research Station.
C. Chang, T. G. Sommerfeldt, T. Entz, and D. R. Stalker.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 2, p 125-136, May 1990. 2 fig, 8 tab, 21 ref.

Descriptors: *Agricultural practices, *Alberta, *Canada, *Cropland, *Soil water, *Water conservation, Cereal crops, Fallowing, Groundwater recharge, Precipitation, Recharge, Soil profiles, Soil-water-plant relationships, Uncertainty.

Nineteen years of soil moisture content data at Lethbridge and two locations near Turin (Turin 1 and Turin 2) in southern Alberta, Canada, were examined to evaluate the efficiency of fallow for conserving moisture, and to calculate the long-term mean amount of water recharge during growing and nongrowing seasons under a fallow-cereal, two-year rotation and a continuous cropping system. Soil samples were taken annually from 1969 to 1987 to a depth of 120 cm in 30-cm intervals in the spring and fall. A method for testing nonstandard data using localized uncertainty associated with sliding polynomial smoothing was used to test for differences in the soil moisture contents due to cultural practices. The available soil moisture content was at least 50% of available water-holding capacity of the profile for the fallow treatment at Lethbridge and Turin 2, and, except in some years, at Turin 1. At seeding time, there was an average of 69 mm more available water (AW) in the fallow field than in the continuous cropping field at Lethbridge and 30, 35, and 27 mm more AW in the fallow field than in the fresh stubble field of Lethbridge, Turin 1, and Turin 2, respectively. The overall mean precipitation conserved as soil moisture for the fallow-cereal rotation practice was 23, 29, and 23% for Lethbridge, Turin 1, and Turin 2, respectively. The significantly higher soil water content at the 90 to 120-cm depth for the fallow field indicates that the soil water recharge from precipitation might be deeper in the fallow field than in continuous cropping and fresh stubble of rotation fields. The deeper recharge could increase the available soil moisture for crop production and it could also contribute to groundwater recharge. (Author's abstract)
W91-04551

HYDRAULIC CHARACTERISTICS OF FOUR PEATLANDS IN MINNESOTA.
Ruppin Inst., Emek Hefer (Israel).
For primary bibliographic entry see Field 2H.
W91-04553

EFFECT OF SOIL WATER CONTENT ON THE WINTER SURVIVAL OF WINTER WHEAT, RYE AND TRITICALE.
Agriculture Canada, Sainte-Foy (Quebec). Research Station.
Y. Cloutier, A. Comeau, M. Bernier-Cardou, and D. A. Angers.
Canadian Journal of Plant Science CPLSAY, Vol. 70, No. 3, p 667-675, July 1990. 5 fig, 17 ref.

Descriptors: *Cereal crops, *Cold resistance, *Soil water, *Soil-water-plant relationships, Drought effects, Ice, Planting management, Soil temperature, Survival, Tolerance, Wheat, Wilting point.

Winterhardiness of plants is related to a variety of genetic traits including tolerance to freezing, winter desiccation, ice encasement, and snow molds. Cultivars with desired characteristics of drought or ice tolerance could be selected using devices simulating the desired winter conditions. A field study was conducted to determine the effect of soil moisture on the survival of three winter cereal species. Treatments were applied by watering and weighing the soil to the desired water content. Plants were overwintered in a plastic greenhouse in 1988 and 1989, in which the air was not heated, but the soil was slightly heated on cold days to avoid very low temperatures. Soil temperature did not fall below minus 16 C. Soil temperature rate of change was dependent on moisture content. Puma winter rye and Otrastajuskaja 38 winter wheat were the hardiest, followed by Wintri winter triticale and Norstar winter wheat. Harus winter wheat was less hardy, and Champlein winter wheat was totally winter killed. The highest survival rate was obtained at moderate to high soil moisture content. The soil contained 44% water at field capacity and 19% at the wilting point. The drier the soil in the range 13-23%, the greater the mortality indicating a negative effect of long-term drought on plant survival. By contrast, the wettest treatments: 58% and partial ice encasement, did not reduce the survival. However, total ice encasement killed 50-75% of the plants depending on the cultivar. There was an interaction between cultivar and moisture treatment. The data suggest that a moisture level intermediate between the wilting point and field capacity should be sought in studies of cold hardiness. (Author's abstract)
W91-04554

SALT OF THE EARTH: SECONDARY SOIL SALINIZATION IN THE AUSTRALIAN WHEAT BELT.
Western Australia Univ., Nedlands. Dept. of Geography.
For primary bibliographic entry see Field 3C.
W91-04557

SOIL TEMPERATURE UNDER CONVENTIONAL AND MINIMUM TILLAGE: SIMULATION AND EXPERIMENTAL VERIFICATION.
Alberta Univ., Edmonton. Dept. of Soil Science.
R. F. Grant, R. C. Izaurralde, and D. S. Chanasyk.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 289-304, August, 1990. 4 fig, 2 tab, 20 ref.

Descriptors: *Model studies, *Simulation models, *Soil moisture, *Soil temperature, Barley, Depth, Diurnal variation, Tillage.

Residue management may affect soil temperature, and consequently soil biological processes, by influencing energy exchange fluxes at the soil surface. Simulation models in which these fluxes are estimated allow the investigation of hypotheses concerning the effect of residue management on soil thermal regimes. The simulation technique used involves a finite difference approximation to the estimation of hourly water and heat fluxes through a one-dimensional, layered soil medium, with boundary conditions determined at the surface from surface energy exchange processes, and below the profile from source/sink dynamics. Crop and residue cover were considered as they influence radiative fluxes at the soil surface. Estimated soil temperatures were compared to recorded soil temperatures at 0.05 m and 0.15 m depths in plots of barley grown under conventional (CT) and minimum (MT) tillage which left 90% and 30% of the soil surface exposed, respectively. Although diurnal trends in soil temperature were consistent with those recorded, the amplitude of diurnal variation was overestimated by the model under CT, and underestimated under MT. Standard differences between recorded and estimated hourly-averaged temperatures were about 2.5 C at 0.05 m, and half as much at 0.15 m. The model failed to simulate the consistently lower soil temperatures recorded under MT during the early part of the growing season that may have been caused by longer term tillage effects, such as the persistence of ice lower in the soil profile. Examination of early season temperature effects will require longer term simulations in which the hydrologic and thermal implications of snow and ice are considered. (Author's abstract)
W91-04582

DEGRADATION STUDIES WITH 14C-FENOXAPROP IN PRAIRIE SOILS.
Agriculture Canada, Regina (Saskatchewan). Research Station.
For primary bibliographic entry see Field 5B.
W91-04584

NEW METHOD TO MEASURE BULK ELECTRICAL CONDUCTIVITY IN SOILS WITH TIME DOMAIN REFLECTOMETRY.
Agricultural Univ., Wageningen (Netherlands). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7B.
W91-04585

LEACHING OF A HIGHLY SALINE-SODIC SOIL IN SOUTHERN ALBERTA: A LABORATORY STUDY.
Alberta Agriculture, Lethbridge. Land Evaluation and Reclamation Branch.
For primary bibliographic entry see Field 3C.
W91-04586

BIOLOGICAL TRANSFORMATIONS OF 1,1,1-TRICHLOROETHANE IN SUBSURFACE SOILS AND GROUND WATER.
Dow Chemical Co., Midland, MI. Health and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-04743

EVALUATION OF TWO MODELS DESCRIBING THE STEADY DISCHARGE FROM A CONSTANT HEAD WELL PERMEAMETER INTO UNSATURATED SOIL.
Institute for Soil Fertility, Haren (Netherlands). Dept. of Soil Physics and Root Ecology.
M. Heinen, and P. A. C. Raats.
Soil Science SOSCAK, Vol. 150, No. 1, p 401-412, 1990. 6 fig, 7 tab, 25 ref.

Descriptors: *Hydrologic models, *Infiltration, *Mathematical models, *Model studies, *Permeameters, *Soil water, *Unsaturated flow, *Wells, Comparison studies, Error analysis, Hydraulic conductivity, Saturation, Soil saturation, Water level fluctuations.

Two approximate analytical models (model-Philip and model-Guelph) that describe the steady outflow from a constant-head-well permeameter into an unsaturated soil were evaluated. The two models recognize the existence of a saturated zone around the borehole and consider the combined influence of the saturated-unsaturated soil on the steady outflow from the well. The two models yield an analogous relation between the steady discharge (Q), the field-saturated hydraulic conductivity (K), and the matric flux potential (phi) or the sorptive number (a) with only the coefficients differing from each other. For a special range of steady discharge ratios, model-Philip yields a

larger K value than model-Guelph. The two models yield nearly equal phi values. The lower and upper boundaries of this special discharge ratio range arise from the fact that K and phi are both necessarily positive. Seemingly negative values of K or phi can be explained by the fact that most soils are heterogenous and/or anisotropic. Model-Philip leads to somewhat larger errors introduced by disregarding flow in the unsaturated zone than does model-Guelph. For both models these errors decrease as the ponded water level increases or as capillarity decreases. (Author's abstract)
W91-04796

MODERN KRIGING AND CLASSICAL GAUSSIAN TECHNIQUES--DO THEY NECESSARILY YIELD IDENTICAL RESULTS.
Grenoble-1 Univ. (France).
G. H. Schmitz, E. M. Kiefer, and M. Vauclin.
Advances in Water Resources AWREDI, Vol. 13, No. 2, p 90-97, 1990. 4 fig, 1 tab, 9 ref, 3 append. German Science Foundation (DFG) No. Se 316/10.

Descriptors: *Kriging, *Probability distribution, *Soil water, *Statistical analysis, *Stochastic models, Comparison studies, Distribution patterns, Regression analysis, Soil properties.

Stochastic modeling of soil water transfer can use two different techniques to approximate the spatial variation of the hydrogeological parameters: the classical Gaussian conditional mean approach; or the more recent estimation technique called 'kriging.' A comprehensive comparison was made between the Gaussian conditional mean method and kriging. While both systems use the deterministic and given character of the measured values differently, the regression models are principally applied in the same way. The common goal is to extract from the random function the unknown mean respective to the trend, or in geostatistical terms, the drift. To achieve this goal without further complicating the stochastic model, the unknown mean is described by a regression model which assumes a linear relationship between arbitrary functions of space, and the unknown mean. The Gaussian approach is based on the observation that the spatial variation of soil properties around the mean is normally or lognormally distributed. This technique regards the measured values as given and deterministic, while the values of the parameters of interest at those points with no measurements are considered as random variables. Kriging uses the term 'regionalized variable' to characterize a spatial phenomenon which shows a certain structure. This might be, for example, some arbitrary soil property. Contrary to the Gaussian model, the geostatistical approach does not seem to employ any assumption as to the special form of the probability distribution. The common features of the two systems were explored and interpreted and it was determined that the outcome of the kriging and the Gaussian models was identical. It was found that the assumption of normally distributed parameters implicitly enters the kriging model through the linear form of the kriging estimator; and the handicap of the Gaussian approach, the lack of an equation to correctly describe the actual variance of the estimates, could be overcome. (White-Reimer-PTT)
W91-04829

SURVEY OF DOMAIN DECOMPOSITION TECHNIQUES AND THEIR IMPLEMENTATION.
Wyoming Univ., Laramie. Dept. of Mathematics.
R. E. Ewing.
Advances in Water Resources AWREDI, Vol. 13, No. 3, p 117-125, 1990. 37 ref. Office of Naval Research Contract No. 0014-88-K-0370.

Descriptors: *Computers, *Data processing, *Domain decomposition, *Fluid flow, *Mathematical analysis, *Model studies, *Porous media, Aquifers, Case studies, Flow equations, Multiphase flow, Numerical models, Oil wells, Simulation models, Wells.

Field-scale simulations of fluid flow in porous media often involve problems that are so large that solution on the full computational domain is either impossible or extremely inefficient. Domain decomposition techniques have been developed to allow these large processes to be split into pieces that can be solved independently and then put back together to give an approximation of the total solution. The advent of powerful parallel architecture supercomputers has greatly revitalized the study and use of domain decomposition techniques. These methods can be used globally to treat different portions of the computational domain separately on different processors, or locally to resolve important local physical behavior. For large-scale simulation problems, domain decomposition offers significant capabilities in computational efficiency. Some of the leading domain decomposition techniques that are applicable to various aspects of porous media flow are reviewed, and the implementation of some of these methods in large-scale multiphase flow problems illustrated. Domain decomposition techniques depend rather strongly on a thorough understanding of the relationship between the subdomain and the boundary problems. The internal boundary discretizations and computations must accurately reflect the differential operator across the artificial boundaries induced through the domain decomposition. This is especially important if different types of discretizations or different constitutive equations are used on separate subdomains. Examples used to illustrate the uses of domain decomposition techniques include: (1) a single-phase, steady-state flow; (2) a three-phase coning problem; (3) a multiwell, multiphase problem; (4) an oil reservoir with four producing wells surrounded by an aquifer; and (5) throughput in blocks around a well. (White-Reimer-PTT)
W91-04831

CENTRIFUGAL MODELING OF DRAINS FOR SLOPE STABILIZATION.
McClelland Engineers, Inc., Ventura, CA.
For primary bibliographic entry see Field 8D.
W91-04838

RECONNAISSANCE STUDY OF THE THICKNESS OF THE UNSATURATED ZONE IN THE WESTERN CONTERMINOUS UNITED STATES.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5E.
W91-04855

EFFECTS OF FOLIATION ON THE HYDROLOGIC PROPERTIES OF PIEDMONT SAPROLITE.
Clemson Univ., SC. Dept. of Forestry.
For primary bibliographic entry see Field 2F.
W91-04885

ANALYSIS OF SATURATED HYDRAULIC CONDUCTIVITY IN A FORESTED GLACIAL TILL SLOPE.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Land and Water Resources.
For primary bibliographic entry see Field 2F.
W91-04909

REACTIONS BETWEEN ALUMINUM AND SULFATE IN DILUTE NUTRIENT SOLUTIONS WITH VARYING DEGREES OF HYDROLYSIS.
Florida Univ., Lake Alfred. Citrus Experiment Station.
For primary bibliographic entry see Field 2K.
W91-04910

DEGRADATION OF ATRAZINE IN SOIL THROUGH INDUCED PHOTOCATALYTIC PROCESSES.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
For primary bibliographic entry see Field 5B.
W91-04911

PSYCHROMETRIC MEASUREMENT OF SOIL WATER POTENTIAL STABILITY OF CALIBRATION AND TEST OF PRESSURE-PLATE SAMPLES.
New Mexico State Univ., Las Cruces.
For primary bibliographic entry see Field 7B.
W91-04912

ANALYSIS OF OUTFLOW EXPERIMENTS SUBJECT TO SIGNIFICANT PLATE IMPEDANCE.
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
J. D. Valiantzas.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2921-2929, December 1990. 9 fig, 1 tab, 14 ref.

Descriptors: *Analytical methods, *Diffusivity, *Flow resistance, *Hydraulic conductivity, *Impedance, *Soil water, Hydraulic properties, Hydrologic models, Mathematical models, Plate impedance, Pressure distribution, Soil physical properties.

A new method is developed for the determination of the diffusivity-water content relationship from pressure-outflow experiments when the impedance of the supporting porous plate has to be taken into account. Gardner's equation was modified to take into account the effect of porous plate impedance. A function is derived to correct the modified approximation for various exponential functions, assuming a linear variation of the pressure head over the pressure increment. When the corrector factor is expressed as a function of particular reduced variable, the variation can be described approximately by a single relation irrespective of the particular form of the function and the reduced plate resistance parameter. The classic one-step outflow procedure for the determination of soil water diffusivity does not use the early linear part of the outflow versus the square root of time curve, where the effect of plate impedance is not negligible. The present method also can be applied to the linear part of the outflow curve which is considerably extended when the effect of the plate impedance is significant. The suggested procedure requires additional information--the retention curve and the conductivity value of the porous plate. The method was tested by simulating outflow experiments with significant plate impedance and using data obtained to calculate diffusivities, as well as analyzing experimental outflow data for a real soil. (Author's abstract)
W91-04921

PREFERENTIAL FLOW AND THE GENERATION OF RUNOFF: 1. BOUNDARY LAYER FLOW THEORY.
Bern Univ. (Switzerland). Geographisches Inst.
For primary bibliographic entry see Field 2E.
W91-04933

2H. Lakes

LANDSAT TM STUDY OF AFFORESTATION IN NORTHERN SCOTLAND AND ITS IMPACT ON BREEDING BIRD POPULATIONS.
National Remote Sensing Centre, Farnborough (England).
For primary bibliographic entry see Field 7B.
W91-03948

QUANTITATIVE REMOTE DETECTION OF SUSPENDED SEDIMENT CONTENT AND CHLOROPHYLL CONCENTRATION OF WATER IN DIFFERENT DEPTHS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 7B.
W91-03949

DATA PROCESSING FOR THE DETERMINATION OF PIGMENTS AND SUSPENDED SOLIDS FROM THEMATIC MAPPER DATA.
Freiburg Univ. (Germany, F.R.). Inst. for Physical Geography.
For primary bibliographic entry see Field 7B.
W91-03952

MONITORING OF SUSPENDED SEDIMENTS IN JATILUHUR RESERVOIR USING SATELLITE IMAGES.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
For primary bibliographic entry see Field 7B.
W91-03954

ESTIMATION OF THE AREA OF LAKE KARIBA, ZIMBABWE, USING LANDSAT MSS IMAGERY.
Aston Univ., Birmingham (England). Remote Sensing Unit.
For primary bibliographic entry see Field 7B.
W91-03964

WETLAND SOIL FORMATION IN THE RAPIDLY SUBSIDING MISSISSIPPI RIVER DELTAIC PLAIN: MINERAL AND ORGANIC MATTER RELATIONSHIPS.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2L.
W91-03978

REAL-TIME SAMPLING STRATEGIES FOR ESTIMATING NUTRIENT LOADINGS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W91-03989

EFFECT OF WIND ON THE DISTRIBUTION OF PHYTOPLANKTON CELLS IN LAKES.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
I. T. Webster.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 989-1001, July 1990. 9 fig, 26 ref.

Descriptors: *Hydrologic models, *Lakes, *Limnology, *Mathematical models, *Phytoplankton, *Wind tides, Floating, Heterogeneity, Light requirements, Nutrient concentrations, Sinking, Spatial distribution, Stratification.

Wind-induced motions influence the distributions of phytoplankton cells in lakes, determining the availability of nutrients and light necessary to their growth. A model is developed that demonstrates how the tendency of phytoplankton cells to float or sink, coupled with wind-induced circulations, leads to horizontal heterogeneity in phytoplankton concentrations in lakes. For the unstratified case after steady state conditions have been attained, modeled concentrations are approximately uniform in the vertical, but they increase (or decrease) at an exponential rate toward the downwind end of the lake is the plankton cells float (or sink). The rate of increase or decrease of concentration along the downwind axis of the lake is shown to depend simply on wind speed, rising or sinking velocity, and lake water depth. The degree of phytoplankton heterogeneity in a lake depends on the ratio of the spatial scale over which concentration varies to the length of the lake. Under certain conditions, the model can be extended to stratified lakes as well. Thus, the model can explain some observations of heterogeneity in plankton concentration within both unstratified and stratified lakes. (Author's abstract)
W91-03995

INTERANNUAL FLUCTUATIONS IN PRIMARY PRODUCTION: DIRECT PHYSICAL EFFECTS AND THE TROPHIC CASCADE AT CASTLE LAKE, CALIFORNIA.
California Univ., Davis. Div. of Environmental Studies.
A. D. Jassby, T. M. Powell, and C. R. Goldman.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 1021-1038, July 1990. 9 fig, 5 tab, 75 ref.
NSF Grant BSR 87-05170.

Descriptors: *California, *Castle Lake, *Climatology, *Fluctuations, *Limnology, *Physical properties, *Primary production, *Trophic level, Ecosystems, El Nino/Southern Oscillation, Rainbow trout, Seasonal variation, Variability, Waterfleas.

Direct physical effects and cascading trophic interactions operate together to determine interannual variability in the seasonal pattern of primary productivity at Castle Lake, California. Principal component analysis was used to investigate the depth-time distribution of productivity for summers 1961 to 1986. Two characteristic patterns were found, together accounting for 60 to 70% of the year-to-year variability. The first pattern corresponds to the deep productivity maximum that forms in the hypolimnion in June and July. Variability in this first pattern arises from the direct effects on phytoplankton populations of year-to-year changes in timing of ice breakup and hydraulic flushing in spring. The first pattern is unusually strong or weak, compared to the long-term average, during the phenomenon of El Nino-Southern Oscillation. A second characteristic pattern corresponds to the mixed-layer productivity maximum that develops in August and September. Variability in this second pattern arises from trophic interactions at higher levels: rainbow trout feed on late-summer Daphnia rosea populations, which in turn graze on the mixed-layer algal community. In addition, some of the variability in the rainbow trout population arises from year-to-year differences in angling pressure from humans. These results demonstrate how interannual variability in an ecosystem property (primary productivity) can be controlled by forces acting simultaneously through the top and base of the food web. (Author's abstract)
W91-03996

DYNAMIC BEHAVIOR OF SUSPENDED SEDIMENT CONCENTRATIONS IN A SHALLOW LAKE PERTURBED BY EPISODIC WIND EVENTS.
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.
R. A. Luettich, D. R. F. Harleman, and L. Somlyody.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 1050-1067, July 1990. 8 fig, 2 tab, 43 ref.

Descriptors: *Lakes, *Limnology, *Sediment concentration, *Suspended sediments, *Wind, Data collections, Deposition, Dynamics, Fall velocity, Grain size, Hungary, Lake Balaton, Mathematical models, Particle size.

Due to their small fall velocities, fine-grained particles are transported easily by flows. An understanding of the dynamic behavior of these particles is particularly important in shallow lakes, since there they may repeatedly settle to the bottom and be resuspended throughout the water column. Field experiments were conducted in Lake Balaton, a large (surface area, 600 sq. km.) but shallow (mean depth, 3.2 m) lake in Hungary, to quantify the resuspension and deposition of bottom sediment due to episodic storm events. Measurements were made of wind speed and direction, surface waves, mean water velocity, and suspended sediment concentration. During significant wind events, the computed bottom stress due to surface waves dominated that due to the mean current, and therefore surface waves were assumed to be the major cause of sediment resuspension. A simple model for the depth-averaged suspended sediment concentration based on surface wave height was calibrated with about 10 h of data collected during one storm event and verified against 15 d of data collected at the same site. The success of the suspended sediment model, which assumes that the bottom sediment was noncohesive, is surprising since the bottom material was composed predominantly of sediment in the clay and fine-silt size ranges. This fit may indicate the presence of a thin surface layer of loosely bound sediment that is continuously involved in resuspension. The suspended sediment model could easily be integrated into a water quality model, provided that lateral transport is negligible, or it could be used to provide the bottom boundary condition for a more general suspended sediment transport model in which advective transport is included. (Author's abstract)
W91-03997

GRANITE WEATHERING AND THE SENSITIVITY OF ALPINE LAKES TO ACID DEPOSITION.
R. E. Stauffer.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 1112-1134, July 1990. 6 fig, 8 tab, 58 ref.

Descriptors: *Acid rain effects, *Alpine regions, *Mountain lakes, *Atmospheric chemistry, *Granites, *Lake acidification, *Limnology, *Sensitivity analysis, *Thermodynamics, *Weathering, Acidity, Calcium, Carbon dioxide, Dissolved organic carbon, Glaciation, Mathematical models, Sodium, Soil chemistry, Stoichiometry.

Lake chemical data from the National Surface Water Survey were corrected for the effects of regional atmospheric deposition and then used to evaluate the role of weathering in supplying base cations, silica, sulfate, and alkalinity to surface waters in alpine versus subalpine and in glaciated versus unglaciated granitic terrane of the western and southeastern United States. Thermodynamic models, idealized reaction stoichiometry, and multivariate regression involving solutes and geographic variables indicate that irreversible weathering can largely account for lake chemistry. By contrast, relatively minor roles are played by reversible ion exchange in soils and sediments, terrestrial bioaccumulation, and transformation in lakes. The regional patterns in lake acidity components (nitrate, sulfate, dissolved organic carbon, carbon dioxide) and statistical relationships between acidity and base cations demonstrate that rock weathering is limited by acid inputs in many alpine catchments prior to fall overturn. The empirical success of the Henriksen alkalinity model depends on a high calcium:sodium weathering ratio. The latter increases with increasing physical disturbance of the catchment (juvenility), hence under natural circumstances attains a maximum as a result of ongoing or recent glaciation. The Henriksen model fails in geochemically old terrane, where cation losses accompanying silicate weathering attain steady state proportions. (Author's abstract)
W91-03998

DENITRIFICATION AND PHOTOSYNTHESIS IN STREAM SEDIMENT STUDIED WITH MICROSENSOR AND WHOLE-CORE TECHNIQUES.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
L. P. Nielsen, P. B. Christensen, N. P. Revsbech, and J. Sorenson.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 1135-1144, July 1990. 4 fig, 1 tab, 27 ref.

Descriptors: *Denitrification, *Photosynthesis, *Sediment chemistry, *Streams, Aerobic conditions, Algal growth, Ammonium ion, Light intensity, Microsensors, Nitrates, Oxygenation, Plant physiology.

The effect of light on benthic photosynthesis, denitrification, and assimilation of ammonium ion and nitrate ion in stream sediments was studied with whole-core techniques and with oxygen and nitrogen dioxide microsensors. Photosynthetic oxygen production increased the thickness of the aerobic surface layer from 1.5 mm in the dark to approximately 3.5 mm at a light intensity saturating photosynthesis. The oxygen flux changed concurrently from net uptake to net release and the overall rate of denitrification was reduced by 70%. Denitrification was always restricted to a narrow zone immediately below the aerobic-anaerobic interface. Calculated nitrate ion microprofiles showed that the overall denitrification was primarily dependent on the thickness of the aerobic layer which acted as a barrier for diffusion of nitrate ions from the overlying water. In the light, algal nitrate ion assimilation could exceed nitrate ion consumption by denitrification when availability of ammonium ion was low. Assimilation of nitrate, however, had no influence on the flux of nitrate ion to the denitrification zone, since assimilation occurred relatively close to the sediment surface. (Author's abstract)
W91-03999

IRON REDOX EFFECTS ON PHOTOSYNTHESIS PHOSPHORUS RELEASE FROM DISSOLVED HUMIC MATERIALS.

Kent State Univ., OH. Dept. of Biological Sciences.
J. B. Cotner, and R. T. Heath.
Limnology and Oceanography LIOCAH, Vol. 35, No. 5, p 1175-1181, July 1990. 5 fig, 3 tab, 23 ref.

Descriptors: *Acid lakes, *Cycling nutrients, *Humic substances, *Iron compounds, *Limnology, *Phosphorus, *Photosynthesis, Chlorophyll a, Nutrient uptake, Chromatography, Dissolved organic carbon, Orthophosphates, Oxidation, Photoreduction.

The concentration of Fe(3+) in a lake can be important to the dynamics of phosphorus because orthophosphate sorbs to the surfaces of ferric oxides and precipitates with these colloids under aerobic conditions. Factors controlling the release of phosphorus (including redox potential and dissolved organic carbon compound levels) from dissolved humic material-iron complexes were studied in an acid bog lake. Gel-permeation chromatography of lake water labeled with phosphate-32 ions was used to separate high-molecular weight and low-molecular weight fractions of phosphorus compounds. Ferric ion additions and irradiation with ultraviolet (UV) light increased the release of a labeled compound coeluting with orthophosphate from void volume fractions. Oxidation rates of Fe(2+) in whole lake water were much slower than photoreduction rates, which suggests that, in UV light, iron accumulated as Fe(2+). Fe(2+) concentrations decreased concomitant with a June increase in chlorophyll a in the lake water. Biotic uptake of Fe(2+) may deplete the ambient pool of both Fe(2+) and Fe(3+) in summer and make photosensitive processes less important at this time. (Author's abstract)
W91-04000

TRANSBOUNDARY METAL POLLUTION OF THE COLUMBIA RIVER (FRANKLIN D. ROOSEVELT LAKE).
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 5B.
W91-04016

TIME- AND VERTICAL DISTRIBUTION OF BACTERIOPLANKTON IN A SHALLOW EUTROPHIC RESERVOIR.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
R. Markosova, M. Benediktova, and A. Volkova.
Water Research WATRAG, Vol. 24, No. 9, p 1057-1067, September 1990. 8 fig, 4 tab, 37 ref.

Descriptors: *Aquatic bacteria, *Eutrophic lakes, *Limnology, *Plankton, *Reservoirs, *Temporal distribution, *Vertical distribution, Ammonia, Biological oxygen demand, Chlorophyll, Coliforms, Dissolved oxygen, Seasonal variation, Stratification, Streptococcus.

Development of bacterioplankton was assessed during two subsequent seasons in the eutrophic Hostivar reservoir, Prague, Czechoslovakia. Counts of planktonic bacteria, contents of oxygen, ammonium and chlorophyll a, as well as BOD1 and BOD5 values exhibited large vertical (0-7 m depth) and seasonal (April-October) fluctuations. Direct microscopic counts of bacterioplankton, colony forming units (cfu) of mesophilic, coliform and fecal streptococci showed clear vertical stratification. Highest bacterial density was always observed at a maximal depth of 7 m, whereas the profile under the surface had the lowest numbers. Bacterioplankton numbers estimated by microscopy counting from sampling depths (0.1, 3, and 7 m) were of mean (minimum-maximum) values: 1.92 (0.42-3.63), 2.37 (0.79-7.60) and 3.09 (0.75-8.78) million cells/milliliter. The major controlling factor over the BOD values in the epilimnion was the phytoplankton production, whereas the BOD values in the hypolimnion were controlled most probably by decomposition processes. Extensive bacterial proliferation was found during the second half of the summer period in the anoxic hypolimnion. Maximum values (8.78 million cells/ml) were correlated with the extreme ammonium concentration (maximum 6.018 micrograms/L) with a correlation coefficient r=0.74. The chlorophyll a concentration was relatively high (37-130 micrograms/L) and its contribution to the total nutrient pool was calculated to have been 44% and 57% in the first and second year, respectively. (Author's abstract)
W91-04034

IMPLICATIONS FOR THE DESIGN OF ARTIFICIAL LAKES OF A STUDY OF THE CRAIGAVON LAKES.
Ulster Univ., Ballyronan (Northern Ireland). Freshwater Lab.
For primary bibliographic entry see Field 4A.
W91-04037

SEASONAL COMPARISONS OF WEIGHT LOSS FOR TWO TYPES OF TYPHA GLAUCA GODR. LEAF LITTER.
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
J. W. Nelson, J. A. Kadlec, and H. R. Murkin.
Aquatic Botany AQBODS, Vol. 37, No. 4, p 299-314, September 1990. 4 fig, 6 tab, 27 ref.

Descriptors: *Cattails, *Decomposing organic matter, *Leaves, *Limnology, *Litter, *Marsh plants, *Wetlands, Canada, Manitoba, Marshes, Muskrats, Nitrogen, Phosphorus, Seasonal variation.

Samples of living (2.8% nitrogen, 0.3% phosphorous) and naturally senesced (0.6% nitrogen, 0.05% phosphorus) leaves of cattail (Typha glauca Godr.) were collected from a shallowly flooded stand during July 1979 and February 1980, respectively. Decomposition patterns of the two litter types were compared by adding and removing litter samples from the Delta Marsh, Manitoba, Canada at various intervals during the growing season. Green leaf material, collected just before flowering, decomposed more rapidly than senesced litter during all time periods. Simple exponential decomposition rates differed significantly; -0.0241/day for green litter versus -0.0110/day for senesced litter. Initial rates of organic dry weight loss were not different between seasons for either litter type, but inital rates declined faster later in the summer. Less organic weight was lost during late summer after 2 and 30 days of incubation for both types of litter. However, seasonal effects could not be detected after longer treatment periods. During late summer, siltation of wind-suspended sediments apparently impeded decomposition by depressing oxygen levels and invertebrate activity in the litter samples. Up to 21 and 36 times more nitrogen and phosphorous, respectively would be released from litter toppled by muskrat feeding activity than by natural toppling of dead plant material during the growing season. (Author's abstract)
W91-04050

EVAPOTRANSPIRATION FROM SEDGE-DOMINATED WETLAND SURFACES.
Trent Univ., Peterborough (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W91-04051

COMMUNITY PATTERNS AND ENVIRONMENTAL GRADIENTS OF BUTTONBUSH, CEPHALANTHUS OCCIDENTALIS, PONDS IN LOWLAND FORESTS OF SOUTHERN ONTARIO.
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
For primary bibliographic entry see Field 2I.
W91-04056

PINTAIL, ANAS ACUTA, USE OF MAN-MADE PONDS IN QUEBEC.
Quebec Univ., Trois-Rivieres. Dept. de Chimie-Biologie.
For primary bibliographic entry see Field 6G.
W91-04058

SIMULATION OF NONSTATIONARY, NON-GAUSSIAN WATER LEVELS ON GREAT LAKES.
Coastal Engineering Research Center, Vicksburg, MS.
T. L. Walton, and L. E. Borgman.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 116, No. 6, p 664-685, November/December 1990. 21 fig, 9 ref, append.

Descriptors: *Computer models, *Great Lakes, *Lake morphometry, *Mathematical models, *Simulation analysis, *Water level, Computers, Gaussian time series, Mathematical equations, Statistical analysis, Water level fluctuations.

Nonstationary non-Gaussian time series having correlation structure are common to the coastal engineering field. A methodology for simulating nonstationary non-Gaussian water levels on the Great Lakes was developed for use in providing input scenarios for erosion modeling on the Great Lakes. The methodology utilizes a low-pass filtering technique to reduce the data to a stationary time series after which the data was transformed to a Gaussian series via use of the empirical distribution function coupled with a specialized tail-fitting procedure for the extreme values in the data. The reduced series can then be resimulated in the frequency or time domain. The method allows for the exact duplication of the univariate probability law contained in the data behavior and is thus capable of producing non-Gaussian process behavior related to skewness and high-order moments. It is understood that some of the high-order bivariate moments may not be properly reproduced by this transformation to Gaussian (and the inverse transformation). Applications for which the higher-order bivariate (trivariate, etc.) moments are important should consider other techniques, perhaps based on Volterra series. The method also allows for the treatment of nonstationarity in mean and variance either through including the bursts of nonstationarity of data in deterministic fashion or through a hierarchy of simulation. (Mertz-PTT)
W91-04070

ERROR ANALYSIS OF LIMITING-CASE SOLUTIONS TO THE STEADY-STATE-BIOFILM MODEL.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04071

STATUS OF THE FOURHORN SCULPIN, MYOXOCEPHALUS QUADRICORNIS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04088

STATUS OF THE SPOONHEAD SCULPIN, COTTUS RICEI, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04089

STATUS OF THE BLACKLINE PRICKLEBACK, ACANTHOLUMPENUS MACKAYI, IN CANADA.
J. Houston, and D. E. McAllister.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 24-28, January/March 1990. 3 fig, 12 ref.

Descriptors: *Aquatic habitats, *Canada, *Fish populations, *Limiting factors, *Prickleback, *Spatial distribution, *Water pollution effects, Beaufort Sea, Fisheries, Oil industry, Oil spills, Population dynamics.

The Blackline Prickleback, Acantholumpenus mackayi, is one of the larger eelblennies of the North Pacific and Arctic oceans. The Canadian range probably represents the northeastern fringe of the range and is limited to the Beaufort Sea in the vicinity of the Tuktoyaktuk Peninsula. The species is probably euryhaline, benthophagic and found over sand, mud or silty bottom at depths to 60 m. Very little is known of the biology of the species, especially in Canadian waters where it is rare and vulnerable. The future of these fish in

Canada is threatened by possible habitat loss or degradation through activities connected with the exploration and development of hydrocarbon deposits in the area. In Japan the Blackline Prickleback is used for food. Perturbations in the near shore environment could have deleterious effects on spawning habitat and nursery areas of the larvae. Dredging and drilling activities and vessel traffic in the region of Tuktoyaktuk Harbor could threaten the continued existence of the species in Canadian waters. (Geiger-PTT)
W91-04090

STATUS OF THE BROOK SILVERSIDE, LABIDESTHES SICCULUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04091

STATUS OF THE BANDED KILLIFISH, FUNDULUS DIAPHANUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04092

STATUS OF THE LEAST DARTER, ETHEOSTOMA MICROPERCA, IN CANADA.
K. W. Dalton.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 53-58, January/March 1990. 3 fig, 18 ref.

Descriptors: *Canada, *Construction, *Darters, *Endangered species, *Fish populations, *Limiting factors, *Population dynamics, *Water pollution effects, Aquatic habitats, Competition, Fertilizers, Pesticides, Road construction, Spatial distribution, Swamps, Temperature effects, Turbidity, Urbanization.

Least Darters, Etheostoma microperca, are very small fish found in clear, quiet, well vegetated waters in central North America and the Ozark uplands. The Canadian distribution is restricted to southern Ontario although this is not the Northern fringe of the species range. Both American and Canadian ranges have declined, but remaining Ontario populations seem to be stable. These fish do not appear to be vulnerable in Canada, but the status should be re-evaluated in a few years. Its need for clear water exposes the species to loss of habitat through human activities such as channelization, shoreline development, road construction, drainage of swamps, and impoundments. Water temperature appears to limit the northern range of the species. Pollutants from industrial and domestic activities, such as extensive pesticide and fertilizer use, also have deleterious effects on populations of Least Darter. Directed surveys are needed for proper evaluation of populations because of the Least Darter's small size and elusive habits. (Geiger-PTT)
W91-04093

STATUS OF THE RIVER DARTER, PERCINA SHUMARDI, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04094

STATUS OF THE REDBREAST SUNFISH, LEPOMIS AURITUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04095

STATUS OF THE ORANGESPOTTED SUNFISH, LEPOMIS HUMILIS, IN CANADA.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 5C.
W91-04096

STATUS OF THE BIGMOUTH BUFFALO, ICTIOBUS CYPRINELLUS, IN CANADA.
C. D. Goodchild.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 87-97, January/March 1990. 3 fig, 45 ref.

Descriptors: *Buffalo fish, *Canada, *Endangered species, *Limiting factors, *Population dynamics, *Water pollution effects, Competition, Fish populations, Flooding, Spatial distribution, Spawning, Turbidity.

The Bigmouth Buffalo, Ictiobus cyprinellus, is rare in Canada where its distribution is disjunct and exceedingly limited. In Saskatchewan, populations in some streams are large enough to support a limited commercial fishery but elsewhere in Manitoba and Ontario, populations are extremely small and tenuous judging from the very few specimens that have been collected. In contrast, the species is widespread and abundant throughout the Mississippi River Basin in the United States. Primary limiting factors appear to be temperature and spring flooding to elicit spawning. There is little evidence of predation by other fish. Turbidity, siltation and eutrophication are tolerated by the fish. However, use of toxicants to eradicate other fish also killed Bigmouth Buffalo in the areas of the Upper Rock River drainage of Wisconsin. Interspecific competition may be a limiting factor in this species, but has not been extensively studied. (Geiger-PTT)
W91-04097

STATUS OF THE BLACK BUFFALO, ICTIOBUS NIGER, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04098

STATUS OF THE GOLDEN REDHORSE, MOXOSTOMA ERYTHRURUM, IN CANADA.
C. D. Goodchild.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 103-111, January/March 1990. 4 fig, 44 ref.

Descriptors: *Canada, *Dam effects, *Fish populations, *Limiting factors, *Population dynamics, *Sucker, *Water pollution effects, Aquatic habitats, Channeling, Competition, Endangered species, Predation, Silting, Spatial distribution.

The Golden Redhorse, Moxostoma erythrurum, is known from the Lake Huron, Lake St. Clair, and Lake Erie drainages in southwestern Ontario. Recent records from the Niagara River in Ontario and the Red River in Manitoba, indicate that its range is either expanding or more extensive than had previously been thought. This species is difficult to identify and is often overlooked or misidentified. Three other species of Moxostoma are either threatened or rare in Canada. Canadian populations are contiguous with those in the United States, but are at the northern limit of the range of the species. Little is known of M. erythrurum biology in Canada, but it does not appear to be in great jeopardy at this time. Although apparently more tolerant to habitat alterations than the Black Redhorse, it does seem to be susceptible to changes that affect stream depth or velocity of flow such as damming, channelization, or siltation. The degree of impact from agricultural practices is uncertain, but bound to have a negative effect on Golden Redhorse populations. Angling probably has a negligible effect on Redhorse populations. Both young and adults of this species probably do not compete for food or space with more valued species. Except for young fish, Golden Redhorses are not likely subject to significant predation. (Geiger-PTT)
W91-04099

HYDROLOGY OF A HEADWATER BASIN WETLAND: GROUNDWATER DISCHARGE AND WETLAND MAINTENANCE.
York Univ., North York (Ontario). Dept. of Geography.
N. T. Roulet.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 387-400, October/December 1990. 10 fig, 20 ref.

Descriptors: *Groundwater movement, *Seepage springs, *Surface-groundwater relations, *Swamps, *Wetlands, Aquifers, Headwaters, Ontario.

The link between groundwater and surface hydrology in a small headwater drainage basin in the zone of glacial deposition of southern Ontario south of the Precambrian Shield was examined for two years. The basin is situated in a discharge zone of a regional aquifer and contains a small treed spring-fed swamp. The swamp exists because of the groundwater and has little effect on the maintenance of streamflow. Groundwater input to the swamp is an order of magnitude larger than precipitation. Groundwater of local and regional origin passes through the swamp by two routes: surface streamlets, where groundwater that emerges at specific seepage points in the swamp is conveyed over the ground surface with little interaction with the swamp itself, and by diffuse seepage in the swamp and through the bed of the stream. While the diffuse seepage input is the smaller component of groundwater it maintains the swamp's saturation. Groundwater input to the swamp from the specific seepage-points and diffuse flow varies little over a year; therefore the saturation of the swamp and baseflow from the basin display little seasonal variation compared to other wetland types. The existence of the valley bottom in the headwater basin alters the seasonal and storm hydrology and is important to biogeochemical transformation of emerging groundwater. (Author's abstract)
W91-04106

CARBON, NITROGEN AND PHOSPHORUS STATUS IN DAPHNIA AT VARYING FOOD CONDITIONS.
Norsk Inst. for Vannforskning, Oslo.
D. O. Hessen.
Journal of Plankton Research JPLRD9, Vol. 12, No. 6, p 1239-1249, November 1990. 5 fig, 5 tab, 34 ref.

Descriptors: *Cycling nutrients, *Daphnia, *Lakes, *Limnology, *Nutrients, *Plankton, Aquatic animals, Biomass, Carbon, Foods, Grazing, Nitrogen, Phosphorus, Phytoplankton, Zooplankton.

Zooplankton constitute an important part of the particulate pool of elements in most waters, and play an important role in regulating the phytoplankton community by grazing and nutrient release. During the past few years, increased attention has been paid not only to the quantitative aspect of nutrient release, but also to the relative release as varying N:P ratios may strongly affect competition between algal species. The effects of absolute and relative amounts of C, N, and P in the food on the stoichiometry of a cultured clone of the planktonic crustacean Daphnia magna was studied using repeated experiments with chemostat cultures. The D. magna was fed varying quantities or quality (C:N:P ratio) of phytoplankton in a flow-through chemostat culture. Size-specific dry weight (DW) and egg production varied with a factor of >3, mainly governed by food quantity. A maximum was reached at approximately 4 mg C/L. Mean C/DW was 43.96 plus-or-minus 4.43% and insignificant variations were recorded between the groups of fed animals, but a decrease to 38.09 was found in starved animals. Mean N/DW was 8.18 plus-or-minus 1.02% with small variation between the treatments, and again with the lowest value in starved individuals. The mean P/DW of 1.38 plus-or-minus 0.3% of DW, was largely unaffected by food quantity or the absolute and relative supply of particulate P in the food. The results indicate a rather constant element/DW ratio in Daphnia within normal ranges of food supply. This has strong implications for biomass determinations, and is in particular important when modeling elemental turnover and release from Daphnia (Geiger-PTT)
W91-04111

MIDWATER AND EPIBENTHIC BEHAVIORS OF MYSIS RELICTA LOVEN: OBSERVATIONS FROM THE JOHNSON-SEA-LINK II SUBMERSIBLE IN LAKE SUPERIOR AND FROM A REMOTELY OPERATED VEHICLE IN NORTHERN LAKE MICHIGAN.
Michigan Univ., Ann Arbor. Great Lakes and Marine Waters Center.
J. A. Bowers, W. E. Cooper, and D. J. Hall.
Journal of Plankton Research JPLRD9, Vol. 12, No. 6, p 1279-1286, November 1990. 1 fig, 45 ref.

Descriptors: *Benthic fauna, *Biological studies, *Canada, *Lake sediments, *Limnology, *Shrimp, Aquatic life, Bioturbation, Lakes, Sediments, Submarines.

Submersible dives by the Johnson-Sea-Link II provided an opportunity to observe the opossum shrimp, Mysis relicta, in Lake Superior. Observations included probable mating, midwater and benthic responses, and several swimming modes. While mating the male and female were joined in a ventral to ventral position by interlaced thoracic appendages. During the evening ascent or predawn descent mysids actively swam vertically upwards and downwards using their thoracic appendages which beat metachronally. When escaping from the bottom, mysids thrust their abdomens downwards and rapidly accelerate directly forwards. The midwater response, significantly slower than the benthic response, was a jerky laterally undulatory movement which propelled the animal at a 45 degree angle from the forward motion. In a cruising mode Mysis swims with its periopods, parallel to the bottom, at approximate speeds of 2-5 cm to the (-1) power. A remotely operated vehicle was employed to observe mysids at close range at the sediment-water interface at deep-water and nearshore stations in northern Lake Michigan during May 23-25, 1987. At the 20-m inshore station mysids occurred in significant numbers during the day in very bright light. Mysid swimming behavior on the bottom at deep-water stations significantly fashioned the sediment landscape, a potentially important form of superficial bioturbation. (Author's abstract)
W91-04113

SET MEMBERSHIP APPROACH TO IDENTIFICATION AND PREDICTION OF LAKE EUTROPHICATION.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5C.
W91-04119

IRON TRANSPORT AND DISTRIBUTION BETWEEN FRESHWATER AND SEDIMENTS OVER DIFFERENT TIME SCALES.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
A. F. Vezina, and R. J. Cornett.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 10, p 2635-2644, October 1990. 5 fig, 6 tab, 38 fig.

Descriptors: *Adsorption, *Iron, *Limnology, *Particulate matter, *Sediments, *Water chemistry, Adsorption kinetics, Iron radioisotopes, Isotopic tracers, Lake sediments, Model studies, Sediment-water interfaces, Solute transport.

Observations on the removal of radioactive and stable Fe in experimental limnocorrals were used to test different sediment-water exchange models. The removal of Fe-59 from the water column was rapid (10-15% per day) but relatively insensitive to particle concentration. Radioactive and stable Fe were more concentrated on suspended particles than on settling particles caught by sediment traps. Also, the distribution coefficient of stable Fe was higher in the water column than in the bottom sediments. Modelling of Fe-59 dynamics shows that: (1) adsorption of non-filterable (dissolved and colloidal) Fe onto filterable particles was basically instantaneous at the natural suspended particle concentrations encountered in the experiments; (2) the removal of Fe from the water column of the lake depends on the coagulation rate of non-settling filterable particles into settling particles; and (3) non-settling particles sorb Fe more strongly than settling particles. The model developed and tested using short-term Fe-59 tracer experiments simulated the distribution of stable Fe between the water column and the sediments despite the different distributions of stable Fe and Fe-59 and the different time scales of processes that could influence the behavior of the isotopes. (Author's abstract)
W91-04154

ESTIMATION OF RESERVOIR SURFACE AREAS USING SATELLITE IMAGERY, UPPER GUNNISON RIVER BASIN, COLORADO.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 2D.
W91-04234

DOMINANT PHYTOPLANKTERS AND ENVIRONMENTAL VARIABLES IN ROODEPLAAT DAM, PRETORIA, SOUTH AFRICA.
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany.
A. J. H. Pieterse, and M. A. Rohrbeck.
Water SA WASADV, Vol. 16, No. 4, p 211-218, October 1990. 3 fig, 7 tab, 25 ref.

Descriptors: *Limiting nutrients, *Limnology, *Phytoplankton, *Population dynamics, *Reservoirs, *Species composition, Biomass, Cyanobacteria, Dams, Population density, Pretoria, Roodeplaat Dam, Seasonal variation, South Africa.

The sequence of dominant phytoplankton populations in Roodeplaat Dam was investigated and related to certain environmental variables. Of the inflowing streams, the Pienaars River is the major contributor of dissolved substances resulting in the occurrence of nutrient and phytoplankton gradients in the impoundment. Microcystis aeruginosa, M. incerta, Anabaena circinalis (cyanobacteria), Pediastrum duplex, Sphaerocystis schroeteri (green algae) and Melosira granulata (diatom) were the dominant (reaching highest biomass concentrations) phytoplankton populations. Marked spatial differences in phytoplankton composition were recorded. Cyanobacteria were almost always dominant in the impoundment at the Pienaars River and Hartbees Spruit sampling positions, while green algae and diatoms were at times better represented at the dam wall and Edenvale Spruit sampling positions. Seasonal sequential patterns were most probably influenced by temperature, the onset and duration of stratification, underwater light availability, water inflow (i.e. water retention time) and possibly turnover. Inorganic phosphorous was the primary growth-rate limiting nutrient, but annual differences in phytoplankton composition, such as the appearance and dominance of Anabaena circinalis (a nitrogen fixer), may have occurred because inorganic nitrogen became increasingly important as a growth-rate limiting nutrient. (Author's abstract)
W91-04312

GROUNDWATER-LAKE INTERACTIONS: I. ACCURACY OF SEEPAGE METER ESTIMATES OF LAKE SEEPAGE.
Alberta Univ., Edmonton. Dept. of Zoology.
For primary bibliographic entry see Field 7B.
W91-04393

GROUNDWATER-LAKE INTERACTIONS: II. NEARSHORE SEEPAGE PATTERNS AND THE CONTRIBUTION OF GROUND WATER TO LAKES IN CENTRAL ALBERTA.
Alberta Univ., Edmonton. Dept. of Zoology.
For primary bibliographic entry see Field 2F.
W91-04394

GROUNDWATER EXCHANGE RATE OF THE SOUTHERN BALTIC COASTAL LOWLAND.
Gdansk Technical Univ. (Poland). Inst. of Hyrdotechnics.
For primary bibliographic entry see Field 2F.
W91-04404

CHANGES IN THE CHEMICAL COMPOSITION OF CARBOHYDRATES AND PROTEINS IN SURFACE WATER DURING A BLOOM OF MICROCYSTIS IN LAKE SUWA.
Yamanashi Univ., Kofu (Japan). Dept. of Environmental Engineering.
Y. Amemiya, K. Kato, T. Okino, and O. Nakayama.
Ecological Research (Kyoto) ECRSEX, Vol. 5, No. 2, p 153-162, August 1990.3 fig, 4 tab, 14 ref.
Grant-in-Aid, Ministry of Education, Science and Culture, Japan 63304002.

Descriptors: *Algae, *Algal blooms, *Carbohydrates, *Eutrophic lakes, *Japan, *Limnology, *Microcystis, *Proteins, Amino acids, Eutrophication, Lake Suwa, Light, Metabolism, Nutrients, Seasonal distribution, Sugars.

Carbohydrates and proteins in surface water during a bloom of Microcystis, the dominant summer phytoplankton in Lake Suwa, Japan, were analyzed to evaluate the role of Microcystis in organic matter metabolism. Glucose was the predominant sugar constituent of the cellular carbohydrate fraction and decreased in quantity form the inside towards the outside of the cell through the slime layer. Other constituent sugars, in contrast, were present in larger proportions in the lake water. Although the sugar composition of the cells did not change in July and August, during the first period of Microcystis bloom, it changed appreciably in September when the water temperature decreased below 20 C accompanied by the decrease in solar radiation and a marked change in nutrient concentration. It appears that the sugar composition of the cells may change in response to some environmental stresses. In addition, a temporal change in the sugar composition was found, particularly in the fraction containing the slime extracted by shaking. Among the constituent amino acids of the cells, the percentage of arginine, aspartic acid, and leucine decreased from inside toward the outside of the cell, whereas glutamic acid, threonine, serine, and glycine showed an opposite trend. In contrast to the carbohydrates, the percentage composition of each amino acid varied little throughout the period of the bloom. (Author's abstract)
W91-04410

EFFECTS OF WATER LEVEL FLUCTUATION ON THE GROWTH OF NELUMBO NUCIFERA GAERTN. IN LAKE KASUMIGAURA, JAPAN.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
S. Nohara, and T. Tsuchiya.
Ecological Research (Kyoto) ECRSEX, Vol. 5, No. 2, p 237-252, August 1990. 11 fig, 32 ref.

Descriptors: *Aquatic plants, *Japan, *Limnology, *Macrophytes, *Plant growth, *Water level fluctuations, Biomass, Lake Kasumiguara, Leaf area index, Lotus, Typhoons.

Investigations were made of the growth of the lotus, Nelumbo nucifera, in a natural stand in Lake Kasumiguara, Japan. A rise of 1.0 m in the water level after a typhoon in August 1986 caused a subsequent decrease in biomass of N. nucifera from the maximum of 291 g dry weight (dw)/sq m in July to a minimum of 75 g dw/sq m. The biomass recovered thereafter in shallower regions. The underground biomass in October tended to increase toward the shore. The total leaf area index (LAI) is the sum of LAI of floating leaves and emergent leaves. The maximum total LAI was 1.3 and 2.8 sq m/sq m in 1986 and 1987, respectively. LAI of floating leaves did not exceed 1 sq m/sq m. The elongation rates of the petiole of floating and emergent leaves just after unrolling were 2.6 and 3.4 cm/day, respectively. The sudden rise in water level (25 cm/day) after the typhoon in August 1986 caused drowning and subsequent decomposition of the mature leaves. Only the young leaves were able to elongate, allowing their laminae to reach the water surface. The fluctuation in water level, characterized by the amplitude and duration of flooding and the time of flooding in the life cycle, is an important factor determining the growth and survival of N. nucifera in Lake Kasumigaura. (Author's abstract)
W91-04411

SOME LIMNOLOGICAL OBSERVATIONS ON RIVER GANGA.
Central Drug Research Inst., Lucknow (India). Fermentation Technology Div.
C. K. M. Tripathi.
Geophytology GPHTAR, Vol. 19, No. 1, p 4-9, June 1989. 4 fig, 2 tab, 23 ref.

Descriptors: *Ganges River, *India, *Limnology, *Phytoplankton, *Species diversity, Ammonia, Chlorides, Dissolved oxygen, Dissolved solids, Nitrates, Nitrogen, Temperature, Transparency, Water quality.

The River Ganga (India) differs significantly from other rivers, especially at Varanasi, because of geology and geography. Studies on the phytoplankton and its community structure were conducted for 2.5 yr to determine seasonal variation and to uncover correlations among different biological and physico-chemical factors pertaining to water quality. Total number of species is strongly positively correlated with N, equitability index (calculated with Pielou's formula) transparency, and dissolved oxygen and negatively correlated with temperature, total solids, nitrate, and ammonia. Equitability, transparency, and dissolved oxygen showed a strong positive correlation with the Shannon-Weaver diversity index, whereas temperature, total solids, nitrate, nitrite, ammonia, and chloride showed strong negative correlation with species diversity. The river is maintaining a fairly good quality of water as far as biological parameters are concerned. The river maintains excellent physico-chemical conditions for the proper development of biological communities. These physico-chemical and biological parameters show well-demarcated seasonal variations and influence each other in permissible ranges. (Rochester-PTT)
W91-04418

INFLUENCE OF WATER CHEMISTRY ON SIZE STRUCTURE OF ZOOPLANKTON ASSEMBLAGES.
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
A. J. Tessier, and R. J. Horwitz.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 1937-1943, October 1990. 4 fig, 4 tab, 39 ref. NSF Grant BSR-8614765.

Descriptors: *Acid rain, *Hardness, *Limnology, *Species diversity, *Water chemistry, *Zooplankton, Alkalinity, Calcium, Hydrogen ion concentration, New England, New Jersey, New York, Pennsylvania, Spatial distribution, Waterfleas.

A stratified-random selection of all lakes in the northeastern United States was sampled for zooplankton composition, and physical and chemical characteristics during midsummer 1986. In all, 146 lakes were sampled from five geographic subregions and three categories of water alkalinity. No significant variation in total zooplankton abundance among regions or alkalinity categories was found; however, the body-size structure of assemblages was dependent on both alkalinity and geographic subregion. The largest change in size structure occurred at alkalinity levels > 150 microequivalents/L and pH > 7.0, and appeared less related to change in pH than to variation in water hardness. This shift of size structure was caused by a loss of large-bodied zooplankton and an increase in small rotifers with decreasing water hardness. Exploratory analysis revealed that lake stratification also explained significant variation in zooplankton size structure, but was largely independent of the effects of water chemistry. The association of large zooplankton with hard water appears to be casual; large-bodied cladocerans may require high calcium levels. (Author's abstract)
W91-04442

BENTHOS RESPONSE TO DISTURBANCE IN WESTERN LAKE ERIE: FIELD EXPERIMENTS.
DePauw Univ., Greencastle, IN. Dept. of Geology and Geography.
F. M. Soster, and P. L. McCall.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 1970-1985, October 1990. 7 fig, 7 tab, 74 ref. NSF Grants OCE-77-24613, OCE 80-05103; NOAA Grant NA-RED-00036.

Descriptors: *Aquatic animals, *Benthic fauna, *Bottom sampling, *Lake Erie, *Limnology, *Succession, Colonization, Lakes, Life cycles, Population density, Seasonal variation, Species diversity.

Open space (defaunated sediment) was provided on the floor of Lake Erie on 11 occasions during different seasons over a 26 month period. The benthic community that developed was sampled over time and compared with the nearby undisturbed bottom community. A consistent succession of functional and adaptive types was observed. Early colonizers (ostracods, naidid oligochaetes, chironomids) exceeded their natural abundances by two to seven times within 40 days, but decreased in abundance later. They are small and mobile, live and feed close to the sediment-water interface, and reproduce often. Late colonizers (Limnodrilus spp., Ilyodrilus templetoni, and pisidiid bivalves) reached natural abundances only after several months if at all. They are large, infaunal dwellers that grow slowly and reproduce late in life. An intermediate group (Arcteonis lomondi, Specaria josinae, Pristina acuminata, Dero digitata, Procladius sp., and Coelotanypus sp.) reached their natural abundances early but did not exceed them. This successional sequence of functional and adaptive types appeared to be a general response by both shallow freshwater sublittoral and shallow marine subtidal macrofauna to space-providing disturbances despite radical taxonomic dissimilarity. (See also W91-04444) (Author's abstract)
W91-04443

BENTHOS RESPONSE TO DISTURBANCE IN WESTERN LAKE ERIE: REGIONAL FAUNAL SURVEYS.
Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences.
P. L. McCall, and F. M. Soster.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 1996-2009, October 1990. 5 fig, 10 tab, 55 ref. NSF Grant OCE 80-05103, NOAA Grant NA-RED-00036.

Descriptors: *Aquatic animals, *Benthic fauna, *Bottom sampling, *Lake Erie, *Species diversity, *Succession, Grain size, Lake sediments, Spatial distribution, Stress gradients, Wind-driven currents.

Infauna at six stations in western Lake Erie was sampled on four occasions during 1981-1982 to determine if natural patterns of distribution and abundance reflected the response to disturbance that was revealed previously in tray colonization experiments. The distribution of opportunist species was patchy and positively associated with a gradient of bottom disturbance due to prevailing southwest winds. Distribution of late colonizers was more even and either unrelated to the gradient or more abundant in lower stress regions. Sediment grain size was not a significant predictor of benthos distribution, except to the extent that it covaried with bottom stress gradients. Small, shallow-dwelling, early colonizers appeared to suffer higher mortality during an unusually windy period (October 1981 to April 1982) than the larger, deeper-dwelling, late colonizers. A portion of the spatial and temporal variability of benthos in large, shallow lakes is probably the result of differential adaptation to a variety of bottom disturbances. (See also W91-04443) (Author's abstract)
W91-04444

FOOD CHAIN STRUCTURE IN ONTARIO LAKES DETERMINES PCB LEVELS IN LAKE TROUT (SALVELINUS NAMAYCUSH) AND OTHER PELAGIC FISH.
McGill Univ., Montreal (Quebec). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W91-04445

OPTIMIZATION OF INSECTICIDE TREATMENTS IN RIVERS: AN APPLICATION OF GRAPH THEORY FOR PLANNING A BLACK FLY LARVAE CONTROL PROGRAM.
Quebec Univ., Trois-Rivieres. Groupe de Recherche sur les Insectes.
For primary bibliographic entry see Field 4C.
W91-04446

DIRECT AND INDIRECT EFFECTS OF CONSUMERS ON BENTHIC ALGAE IN ISOLATED POOLS OF AN EPHEMERAL STREAM.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 2E.
W91-04447

ARTIFICIAL SEDIMENTS FOR USE IN TESTS WITH WETLAND PLANTS.
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
For primary bibliographic entry see Field 2J.
W91-04453

NITRATE AND AMMONIUM UPTAKE BY PHYTOPLANKTON POPULATIONS DURING THE SPRING BLOOM IN AUKE BAY, ALASKA.
Oceanic Inst., Waimanalo, HI.
J. Kanda, D. A. Ziemann, L. D. Conquest, and P. K. Bienfang.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 5, p 509-524, May 1990. 11 fig, 2 tab, 37 ref. NOAA/NMFS Contract NA-85-ABH-0022.

Descriptors: *Alaska, *Algal blooms, *Algal growth, *Ammonium, *Auke Bay, *Limiting nutrients, *Nitrates, *Nutrients, *Phytoplankton, *Plant metabolism, Biomass, Light intensity, Plant physiology, Seasonal variation, Tracer studies, Uptake.

The importance of nitrate and ammonium as phytoplankton nitrogen sources was examined by nitrogen-15 tracer experiments during the spring bloom in Auke Bay, Alaska. Nitrate and ammonium uptake rates as functions of substrate concentrations and light intensity were experimentally determined. During the early phase of biomass increase, nitrate contributed nearly all of the nitrogen uptake. Ammonium turnover time was several hours, and the high contribution of nitrate reflected the limited ammonium supply. The contribution of ammonium increased during the later period of biomass increase. After the biomass maximum, ammonium contributed the majority of nitrogen, with occasional and sporadic supplies of nitrate causing a biomass increase. Under nutrient-repleted conditions during the early part of the bloom, the nitrate uptake rate was similar to that of ammonium under subsaturating light intensities (<200 microE/sq m/sec) and nitrate concentrations (<1.5 microM), but higher under saturating light intensities and nitrate conditions. After the bloom peak, under nutrient-depleted conditions, the nitrate uptake rate was lower than that of ammonium for all light intensities and nitrate concentrations. Time-course analysis of nitrogen-15 uptake and partitioning into macromolecule fraction indicated a physiological nitrogen deficiency during this period. Cumulative nitrate uptake estimated from nitrogen-15 tracer experiments was comparable to the net decrease in nitrate in the water column; new production defined as nitrate uptake was greater than the sedimentation loss, which accounted for 77% of the nitrate decrease. (Author's abstract)
W91-04461

SEA LEVEL RISE AND FRINGE WETLANDS IN NORTH CAROLINA: RECOMMENDATIONS FROM A WORKSHOP ON MANAGEMENT AND RESEARCH.
East Carolina Univ., Greenville, NC. Dept. of Biology.
For primary bibliographic entry see Field 2L.
W91-04512

SUBMERSED MACROPHYTE GROWTH AT LOW PH: I. CO2 ENRICHMENT EFFECTS WITH FERTILE SEDIMENT.
State Univ. of New York at Binghamton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-04529

PROCESS OF COLONIZATION IN ANTARCTIC TERRESTRIAL AND FRESHWATER ECOSYSTEMS.
British Antarctic Survey, Cambridge (England).
J. C. Ellis-Evans, and D. Walton.
Proceedings of the NIPR Symposium on Polar Biology, No. 3, p 151-163, March 1990. 5 fig, 1 tab, 40 ref.

Descriptors: *Antarctica, *Colonization, *Ecosystems, *Polar regions, *Species diversity, Reproduction, Spatial distribution, Temporal distribution.

Severe and depauperate ecosystems provide excellent sites for studies of colonization. Energy and resource limitations act as effective filters to establishment and development of communities. Propagule availability must be considered from both local and long-distance sources with consequent effects on dispersion and viability. Predominant emphasis on asexual reproduction in many groups imposes a further limitation on populations at the genetic level. At present little is known of the frequency and success of individual colonization events in any Antarctic site, but critical factors in the process are beginning to be identified. Successful colonization is comprised of four components: a viable propagule, a suitable transport mechanism, an acceptable new microhabitat, and successful growth and reproduction. To establish the composition of the propagule rain and the spatial or temporal aspects of transport to the Antarctic, an international program such as BIOTAS seems necessary. (Brunone-PTT)
W91-04531

MICRO-INVERTEBRATE COMMUNITY STRUCTURE WITHIN A MARITIME ANTARCTIC LAKE.
British Antarctic Survey, Cambridge (England).
S. J. McInnes, and J. C. Ellis-Evans.
Proceedings of the NIPR Symposium on Polar Biology, No. 3, p 179-189, March 1990. 5 fig, 13 ref.

Descriptors: *Antarctica, *Benthic fauna, *Ecosystems, *Limnology, *Polar regions, *Species diversity, *Waterbears, Cyanophyta, Invertebrates, Oligotrophic lakes, Population dynamics, Seasonal variation, South Orkney Islands.

The data set was obtained from a transect across a depth profile in Sombre Lake, a small oligotrophic lake on Signy Island, South Orkney Islands. Considerable range existed in both substrate type and the degree of seasonal change in environmental variables experienced along the depth transect. The fauna, composed of benthic micro-invertebrates, was readily observed grazing on the surface of the cyanobacterial mats that form a thin cover on the surface of the sediments. Algal mat composition varied in response to factors such as light, climate, and ice scour. Micro-invertebrate species diversity was limited, but population numbers were high. Throughout the transect distinct depth/habitat preferences were noted within groups and species. In shallow sites, which are ice-free only in summer, Isohypsibius 'rough' and Notholca walterkosteri occurred in high numbers. In the deep sites there were species apparently capable of tolerating winter anoxia, these being largely comprised of tardigrades, and in particular, Isohypsibius 'smooth'. Frozen material could be used for qualitative distribution studies, thus permitting larger numbers of samples to be taken, but could not be used to indicate the proportions of live and dead animals. Single site sampling will potentially give misleading data on faunal diversity and population numbers within a lake. (Brunone-PTT)
W91-04532

CHARACTERIZATION AND HABITATS OF BACTERIA AND YEASTS ISOLATED FROM LAKE VANDA IN ANTARCTICA.
Science Univ. of Tokyo (Japan). Dept. of Biology.
H. Nagashima, J. Nishikawa, G. I. Matsumoto, and H. Itzuka.
Proceedings of the NIPR Symposium on Polar Biology, No. 3, p 190-200, March 1990. 5 fig, 4 tab, 21 ref.

Descriptors: *Antarctica, *Bacteria, *Lake Vanda, *Limnology, *Polar regions, *Population dynamics, *Species diversity, *Yeasts, Aerobic bacteria, Bacterial physiology, Fatty acids, Salt tolerance, Water depth.

Several strains of bacteria and yeast were isolated at various depths of a meromictic lake, Lake Vanda, to clarify their physiological properties in relation to their habitats. Gram-negative rods, strains T-1, T-2, T-14, 3B, and Pseudomonas sp. 3G, were isolated at depths of above 30 m where the temperature is 5 to 7 C and the chlorinity is low. T-1, T-6, 3B, and 3G grow aerobically below 27 C, optimally below 20 C under low salt concentrations (<1% NaCl). Gram-negative aerobic cocci, strains 13A-F, were isolated at a depth of 69 m near the bottom where the temperature is 24 C and the chlorinity is high, up to 76.5 g/kg. Strain 13A grows aerobically at 12 to 36 C, optimally about 30 C under the addition of 0 to 10% NaCl to the culture medium. T-1, T-6, 3G and 13A contain more than 81% of unsaturated fatty acids such as oleic acid (18:1) and palmitoleic acid (16:1). The yeast Candida sp. strains T-3, T-4, T-5, T-9, and T-11 isolated at a depth of 5 m grow below 25 C, optimally about 15 C. They are fermentable and can utilize various sugars such as glucose and sucrose. T-5 and T-9 have 74% and 86% of unsaturated fatty acids such as lineolic acid (18:2), respectively. The presences of psychrophilic bacteria and yeasts in the water column (5 to 30 m), and of halotolerant bacteria in the bottom water (69 m) well correspond to the meromictic property of the lake. (Author's abstract)
W91-04533

SEASONAL CHANGES OF WATER TEMPERATURE AND CHLOROPHYLL CONCENTRATION IN LAKE O-IKE.
National Inst. of Polar Research, Tokyo (Japan).
Y. Ohyama, K. Morimoto, and Y. Mochida.
Proceedings of the NIPR Symposium on Polar Biology, No. 3, p 201-206, March 1990. 4 fig, 8 ref.

Descriptors: *Algal blooms, *Antarctica, *Chlorophyll, *Lake O-ike, *Limnology, *Seasonal variation, *Water temperature, Lake morphology, Plant growth, Polar regions, Water depth.

Seasonal observations of water temperature and chlorophyll concentrations were carried out in Lake O-ike near Syowa Station, Antarctica in 1987. Water sampling was begun at the end of March, performed almost every month, and continued to January, 1988. The lake surface was covered with ice during ten months from March to December. The lake water was cooled through the surface from March to August, but the bottom water remained above 3 C even at the coldest season. According to the results of chlorophyll measurement , the phytoplankton bloom seemed to occur in April (0.80 mg/cu m chlorophyll) and September (1.82 mg/cu m chlorophyll), mainly at lower water layers. (Author's abstract)
W91-04534

HYDRAULIC CHARACTERISTICS OF FOUR PEATLANDS IN MINNESOTA.
Ruppin Inst., Emek Hefer (Israel).
A. Gafni, and K. N. Brooks.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 2, p 239-253, May 1990. 9 fig, 3 tab, 62 ref.

Descriptors: *Groundwater movement, *Hydraulic properties, *Hydrologic properties, *Minnesota, *Organic soils, *Peat bogs, *Peat soils, *Soil water, *Wetlands, Aquifer characteristics, Darcys law, Decomposition, Flow velocity, Hydraulic conductivity, Hydraulic gradient.

Peatlands comprise some of the largest contiguous wetlands in North America. Current and anticipated mining of peatlands for purposes of horticultural and energy production have raised questions concerning the hydrologic impacts associated with such development. A field study in northern Minnesota was conducted to assess the relative importance of factors that control lateral water movement in peatlands. Hydraulic gradients and groundwater velocities were measured for one mined and three unmined peatlands. Groundwater velocities were measured at shallow depths in the organic soil using the point dilution method. Hydraulic conductivities at different soil depths were estimated by applying the field measurements to Darcy's Law. Hydraulic gradients were persistent from early summer through fall and were generally less than 0.1%, a major factor governing rates of lateral water movement in undisturbed peatlands. Maximum groundwater velocities averaged 0.49 cm/h in the upper and least decomposed peat layers and diminished dramatically with depth and increasing decomposition. The von-Post scale of peat decomposition was found to be useful in predicting the hydraulic conductivity of peat layers. The rate of water movement at depths below 35 cm in the natural peatlands averaged less than 0.03 cm/h. The data contribute to a better understanding of the hydrologic function of peatlands. (Author's abstract)
W91-04553

ANNUAL PRODUCTION AND PRODUCTION: BIOMASS RATIOS FOR THREE SPECIES OF STREAM TROUT IN LAKE SUPERIOR TRIBUTARIES.
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
T. F. Waters, M. T. Doherty, and C. C. Krueger.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 470-474, May 1990. 1 fig, 1 tab, 21 ref. NSF Grant DEB76-09761.

Descriptors: *Fish populations, *Great Lakes, *Stream fisheries, *Trout, Alkalinity, Biomass, Growth rate method, Productivity, Standing stock.

Estimates of annual production of stream trout in two Lake Superior tributaries in northeastern Minnesota were made in 1977-1978. The Caribou River (total alkalinity, 34 mg/L as CaCO3) drains part of the north shore of Lake Superior in an igneous rock geology. The Blackhoof River (total alkalinity, 83 mg/L) drains glacial drift and lake clay at the western end of Lake Superior. Annual production of the salmonine populations was estimated by the instantaneous growth rate method. Annual production of brook trout Salvelinum fontinalis in the Caribou River was estimated to be 58.0 kg (wet weight) per hectare, reflecting low water fertility. In the Blackhoof River, annual production consisted of 43.5 kg of brown trout Salmo trutta and 95.7 kg of juvenile rainbow trout Oncorhynchus mykiss per hectare. The total salmonid production of 139.2 kg/hectare in the Blackhoof River appeared to reflect an intermediate level of water fertility. Ratios of annual production: mean standing stock were calculated to be 2.2 for juvenile rainbow trout, 1.7 for brook trout, and 0.9 for brown trout. These values suggest an inverse relation between standing stock and number of age-groups present (three for rainbow trout, four for brook trout, and six for brown trout). (Author's abstract)
W91-04589

CLASSIFICATION OF TEXAS RESERVOIRS IN RELATION TO LIMNOLOGY AND FISH COMMUNITY ASSOCIATIONS.
Texas Parks and Wildlife Dept., Austin. Inland Fisheries Branch.
W. B. Dolman.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 511-520, May 1990. 3 fig, 6 tab, 15 ref. Fish and Wildlife Service Fish Restoration Project F-30-R.

Descriptors: *Fish populations, *Fisheries, *Limnology, *Reservoirs, *Statistical models, *Texas, Classification systems, Cluster analysis, Community structure, Monitoring, Species associations.

A cluster analysis was used to examine associations among 20 fish species in order to develop a classification scheme for 132 large Texas reservoirs. Five major groups of reservoirs were identified by cluster analysis based on species associations. Of 29 reservoirs surveyed previously, 76% were classified into the same species associations from one survey to the next. When 19 environmental varia-

bles were used in canonical correlation analysis of the five reservoir groups, a general east-to-west separation of species associations by water quality and a northwest-to-southeast separation by surface elevation and growing season were found. A discriminant functions model based on a reduced set of nine environmental variables had an unbiased error rate of 18% for predicting the species association in unclassified reservoirs. A stratified sampling scheme based on the classification model decreased the variance of statewide electrofishing catch per effort up to 43% for bluegill Lepomis macrochirus and 23% for largemouth bass Micropterus salmoides over a simple random sample of reservoirs. The model provides a strategy for monitoring statewide fishery trends based on surveys of representative reservoirs with each species association. Managers may use fishery variables other than species abundance to develop models with specific objectives. Classification models may also be used to allocate available management resources based on the number of reservoirs with each species association or to develop regional objectives for fishery population characteristics such as growth, condition, and recruitment rates. (White-Reimer-PTT)
W91-04591

DISTRIBUTIONS AND ABUNDANCES OF EARLY LIFE STAGES OF FISHES IN A FLORIDA LAKE DOMINATED BY AQUATIC MACROPHYTES.
Florida Cooperative Fish and Wildlife Research Unit, Gainesville.
R. Conrow, A. V. Zale, and R. W. Gregory.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 521-528, May 1990. 3 fig, 1 tab, 38 ref.

Descriptors: *Aquatic plants, *Fish populations, *Florida, *Lake fisheries, *Limnology, *Macrophytes, Habitats, Hydrilla, Juveniles, Larvae, Life stages, Panic grass, Spawning.

The early life stages of fishes were sampled with tow nets and light traps in Orange Lake, Florida in order to determine the habitat use and seasonal occurrences of larval and juvenile fishes in a lake dominated by aquatic vegetation. From June 1983 to June 1984, four habitats were sampled, one open water and three vegetated. Vegetated zones were dominated by panic grass, Panicum species, hydrilla, Hydrilla verticillata, or a community of mixed floating and emergent vegetation. Vegetated zones of any type were important nursery areas for the fish assemblage. Mixed vegetation was an important nursery area for juvenile fish of many species, perhaps due to its structural complexity, and the panic grass was especially important for larvae. Larvae of most species first appeared in Orange Lake at temperatures similar to those at which they appear in temperate lakes, but larvae were present on almost all sampling dates (including those in winter). Larvae of golden shiners Notemigonus crysoleucas, threadfin shad Dorosoma petenense, and gizzard shad D. cepedianum appeared on earlier dates than in temperate systems. Larvae of individual species were present over a longer period than in temperate systems, reflecting longer spawning seasons in Orange Lake. Habitat use by larvae was variable for several species; larval bluegills Lepomis macrochirus, which are typically considered limnetic, inhabited panic grass and hydrilla, in addition to open water. (Author's abstract)
W91-04592

MOVEMENTS AND HABITAT USE BY GRASS CARP IN A LARGE MAINSTREAM RESERVOIR.
Alabama Cooperative Fishery Research Unit, Auburn.
M. B. Bain, D. H. Webb, M. D. Tengedal, and L. N. Mangum.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 553-561, May 1990. 4 fig, 39 ref.

Descriptors: *Aquatic weed control, *Carp, *Fish populations, *Hydrilla, *Macrophytes, *Reservoir fisheries, *Tennessee River, Aquatic plants, Dispersion patterns, Fish behavior, Life stages, Monitoring, Temperature effects.

Triploid grass carp Ctenopharyngodon idella were experimentally stocked in a large, open, mainstream reservoir on the Tennessee River in order to describe their movement and dispersion patterns, and to determine if areas infested with hydrilla Hydrilla verticillata were preferentially used. Radio transmitters were surgically implanted in 25 immature grass carp in 1987 and 10 mature fish in 1988. Dispersion and use of vegetated habitat were analyzed separately for summer (warmwater) and fall-spring (coldwater) periods for grass carp stocked in 1987. The fish moved an average of 2.2 km (0.5-6.3 km) during summer 1987 and 0.4 km during the fall-spring period. The grass carp marked in 1987 tended to move upstream during the summer, ranged over an average area of only 0.10 sq km (0.02-0.30 sq km), and moved even less during the fall-spring period. The submersed plant communities most used by the grass carp in 1987 were dominated by hydrilla and all relocated fish were in vegetated areas. The adult grass carp marked in 1988 moved an average of 32.7 km (0.7-71.1 km) during a 4-month monitoring period, did not reduce movements when water temperature declined, traveled both upstream and downstream, and ranged well beyond hydrilla colonies. The difference in behavior between fish stocked in 1987 and those stocked in 1988 appeared to be related to life history stage (juveniles versus adults). Thus, juvenile triploid grass carp seem more likely to provide effective hydrilla control in target areas than adults. (Author's abstract)
W91-04593

SUSPENDED-SEDIMENT DATA IN THE UPPER RIO GRANDE DE LOIZA BASIN, PUERTO RICO.
Geological Survey, San Juan, PR.
S. Guzman-Rios.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Open-File Report 88-324, 1989. 42p, 14 fig, 17 tab, 9 ref. in coop. with the Puerto Rico Dept. of Natural Resources, Environmental Quality Board, Aqueduct and Sewer Authority, US Army Corps of Engineers, and the US Dept. of Agriculture, Soil Conservation Service.

Descriptors: *Data acquisition, *Puerto Rico, *Reservoir silting, *Rio Grande de Loiza, *Silting, *Suspended sediments, Clays, Fluvial sediments, Particle size, Sand, Sediment transport, Silt, Suspended load.

Fluvial sediment, a widely recognized pollutant of surface water, is reducing the efficiency and useful life of almost all reservoirs in Puerto Rico. Sediment transported from the upper basin of the Rio Grande de Loiza is eventually deposited in the bottom of Lago Loiza, a water reservoir. Suspended sediment data were collected from 1983 to 1986 from a 208 sq mi area extending from the headwaters of Rio Grande de Loiza to the Lago Loiza. The drainage areas range from 0.82 sq mi to 89.8 sq mi. Results are based on three years of data from a network of five daily-record stations and five partial-record stations. A total of 2,114 sediment samples were collected and analyzed during the investigation. Instantaneous concentrations of suspended sediment varied from 0 to 56,100 mg/L. Instantaneous suspended sediment loads ranged from 0 tons/day to 817,000 tons/day. A total of 152 suspended sediment samples were analyzed for particle size distribution. Suspended sediment in the streams is composed mostly of silt and clay. Sand content ranged from 6 to 80% during high flows. (Author's abstract)
W91-04640

HUMIC ACIDS: CHARACTERIZATION AND INTERACTIONS IN NATURAL AND WASTEWATER SYSTEMS (JAN 78--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-867857. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 66p.

Descriptors: *Bibliographies, *Humic acids, *Natural waters, *Wastewater treatment, Chemical precipitation, Chlorinated hydrocarbons, Fulvic acids, Metals.

This bibliography contains citations concerning the absorptive and complexation properties of humic and fulvic acids. Characterization and the occurrence of these acids in wastewater systems and natural systems is studied. The interaction of humic substances with metallic pollutants and chlorinated hydrocarbons, and removal of humic acids by precipitation are among the topics discussed. Wastewater treatment processes are discussed in separate bibliographies. (This new bibliography contains 188 citations fully indexed with a title list.) (Author's abstract)
W91-04655

STREAM GEOMORPHOLOGY: EFFECTS ON PERIPHYTON STANDING CROP AND PRIMARY PRODUCTION.
New Mexico Univ., Albuquerque. Dept. of Biology.
For primary bibliographic entry see Field 6G.
W91-04714

ALGAL COLONIZATION UNDER FOUR EXPERIMENTALLY-CONTROLLED CURRENT REGIMES IN A HIGH MOUNTAIN STREAM.
Colorado State Univ., Fort Collins. Dept. of Biology.
For primary bibliographic entry see Field 2E.
W91-04715

SMALL FLUME FOR STUDYING THE INFLUENCE OF HYDRODYNAMIC FACTORS ON BENTHIC INVERTEBRATE BEHAVIOR.
Alberta Univ., Edmonton. Dept. of Entomology.
For primary bibliographic entry see Field 2E.
W91-04716

LIMNOLOGY OF THE SOUTHERN ACID PEAT FLATS, SOUTH-WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Dept. of Zoology.
B. J. Pusey, and D. H. Edward.
Journal of the Royal Society of Western Australia JRSUAU, Vol. 73, No. 2, p 29-46, 1990. 7 fig, 7 tab, 49 ref.

Descriptors: *Australia, *Ephemeral lakes, *Invertebrates, *Limnology, *Peat bogs, *Species diversity, *Water chemistry, *Wetlands, Acidic water, Aquatic habitats, Benthos, Crustaceans, Hydrogen ion concentration, Ponds, Seasonal variation, Species composition, Zooplankton.

Temporal changes in water chemistry and invertebrate community composition, abundance and diversity were monitored for two years and one year, respectively, for aquatic habitats in an extensive area of coastal wetlands of South-western Australia. The locations sampled included permanent and temporary lotic and lentic environments. pH was low and declined to a minimum of 4.1 in winter. Water transparency was also low due to high levels of dissolved organic substances. A distinct effect of season on water chemistry was observed in contrast to changes reported for other small Australian ponds, temporary or otherwise. Significant temporal changes in the density, diversity and composition of the invertebrate fauna (zooplankton and zoobenthos) were recorded. Fish predation was potentially an important determinant of invertebrate diversity and community structure. Few of the insect fauna showed adaptations to ephemerality and fauna known to be associated with temporary waters were, in general, lacking. This is suggested to be due to the predictable seasonality of the climate which allows little distinction between temporary and permanent habitats for a highly seasonal fauna. Similarity of species composition between locations was low for insect fauna, reflecting the lack of specific drought survival mechanisms and the importance of oppor-

tunism and colonization ability. Assemblage similarity was greatest for the crustacean fauna and was attributed to a greater prevalence of drought survival mechanisms. (Author's abstract)
W91-04717

IN SITU TECHNIQUE TO MEASURE BACTERIAL CHEMOTAXIS IN NATURAL AQUATIC ENVIRONMENTS.
Montana State Univ., Bozeman. Dept. of Biology.
N. Kangatharalingam, L. Wang, and J. C. Priscu.
Microbial Ecology MCBEBU, Vol. 20, No. 1, p 3-10, July/August 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Aquatic bacteria, *Attractants, *Bacteria, *Chemotaxis, *Glucose, *Laboratory methods, *Limnology, *Sodium chloride, Assay, Eutrophic lakes, Fluorescence, Natural waters, Reservoirs.

A simple and reliable technique was developed to study bacterial chemotaxis in natural aquatic environments. The technique uses the test chemicals (attractants) in known volumes of semi-solid agar media placed in double layered, highly porous, polyester tubes. Following in situ incubations, bacteria attracted by the test chemicals are enumerated with fluorescence microscopy following acridine orange staining. Studies in a eutrophic reservoir showed that significant numbers of bacteria were attracted to D-glucose and glycine. No significant attractant effects were observed with L-serine, sodium succinate, or sodium chloride. Sodium chloride and sodium succinate treatments repulsed 18% and 2% bacteria, respectively, compared to the controls. This repulsion was not statistically significant. (Geiger-PTT)
W91-04722

PERSISTENCE OF GENETICALLY ENGINEERED ERWINIA CAROTOVORA IN PERTURBED AND UNPERTURBED AQUATIC MICROCOSMS AND EFFECT ON RECOVERY OF INDIGENOUS BACTERIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
V. S. Scanferlato, G. H. Lacy, and J. Cairns.
Microbial Ecology MCBEBU, Vol. 20, No. 1, p 11-20, July/August 1990. 3 fig, 30 ref.

Descriptors: *Aquatic bacteria, *Colonization, *Erwinia, *Genetic engineering, *Thermal stress, *Water pollution effects, Competition, Nutrients, Predation, Thermal pollution.

Genetically engineered Erwinia carotovora persisted significantly longer in thermally perturbed microcosms (35 days) than in non-stressed microcosms (5 days). Decreased pressure of competitors and predators and increased nutrient availability were examined as the most probable reasons for greater vulnerability of perturbed microcosms to colonization by genetically engineered microorganisms (GEMs). Indigenous bacteria that competed with GEMs for the same nutrient sources (protein, cellulose, pectate) were present immediately after perturbation in densities one to two orders of magnitude lower than in unperturbed microcosms, but their populations increased to densities significantly higher than in unperturbed microcosms 10 to 15 days after inoculation. Predators of bacteria (protozoans, cladocerans, nematodes, and rotifers) were present during the experiment in unperturbed microcosms, while dense populations of bacteriovorous nanoflagellates developed in perturbed microcosms. Preemptive inoculation of perturbed microcosms with GEMs did not have a long-lasting effect on the recovery of total, proteolytic, cellulolytic, and pectolytic bacteria in perturbed microcosms, indicating the absence of competitive exclusion. (Author's abstract)
W91-04723

CORRELATION OF NONSPECIFIC MACROMOLECULAR LABELING WITH ENVIRONMENTAL PARAMETERS DURING (H3)THYMIDINE INCORPORATION IN THE WATERS OF SOUTHWEST FLORIDA.
University of South Florida, St. Petersburg. Dept. of Marine Science.
W. H. Jeffrey, J. H. Paul, L. H. Cazares, M. F. DeFlaun, and A. W. David.
Microbial Ecology MCBEBU, Vol. 20, No. 1, p 21-35, July/August 1990. 4 fig, 4 tab, 44 ref. Department of Commerce Grant NA86AA-D-SG068. NSF Grant BSR 8605170.

Descriptors: *Bacteria, *DNA, *Nucleic acids, *Nutrients, *Radioactive tracers, *Tracers, Alafia River, Aquatic bacteria, Bayboro Harbor, Chlorophyll a, Crystal River, Diurnal variation, Florida, Medard Reservoir, Nitrogen, Organic carbon, Phosphates, Reservoirs, Rivers, Salinity.

During routine (H3)-thymidine incorporation measurements of environmental samples, significant amounts of radioactivity are often incorporated into macromolecules other than DNA. Although the percentage of nonspecific labeling varies both temporally and spatially, the causes of these variations remain unknown. Correlations between the percent incorporated radioactivity in DNA and a variety of experimental and environmental parameters measured in the Alafia River, Crystal River, Medard Reservoir, and Bayboro Harbor in Florida were examined. The amount of radioactivity incorporated into DNA ranged from 6 to 95%. Nonspecific labeling began immediately upon the addition of (H3)-thymidine and was linear over time. Labeling patterns were independent of both the amount of thymidine added and cell-size fraction. A two year study of Bayboro Harbor indicated no conclusive relationship between nonspecific labeling and seasonality. The amount of radioactivity incorporated into DNA was inversely correlated with total rates of thymidine incorporation and a strong diurnal pattern was observed in the Crystal River. No consistent relationship was observed between labeling patterns and primary productivity, chlorophyll a, particulate DNA, dissolved DNA, bacterial cell numbers, temperature, salinity, or dissolved organic carbon. The only relationship with dissolved inorganic nutrients (N and P) occurred in the Crystal River. In this phosphate limited river, the percent of radioactivity incorporated into DNA was positively correlated with phosphate concentrations. These results indicated that nonspecific labeling is not dependent on any one parameter but may be a function of many interacting environmental factors or a function of the specific ambient bacterial population. (Author's abstract)
W91-04724

MICROBIAL MANGANESE REDUCTION MEDIATED BY BACTERIAL STRAINS ISOLATED FROM AQUIFER SEDIMENTS.
Lyon-1 Univ., Villeurbanne (France). Lab. de Microbiologie-Physiologique et Appliqueee.
For primary bibliographic entry see Field 2K.
W91-04726

SEASONAL DEVELOPMENT OF ANOXYGENIC PHOTOTROPHIC BACTERIA IN A HOLOMICTIC DRUMLIN LAKE (SCHLEINSEE, F.R.G).
Konstanz Univ. (Germany, F.R.). Fakultaet fuer Biologie.
B. Eichler, and N. Pfennig.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 369-392, October 1990. 10 fig, 6 tab, 44 ref.

Descriptors: *Aquatic bacteria, *Lakes, *Limnology, *Photosynthesis, *Sulfur bacteria, *Thermal stratification, Iron, Lake sediments, Manganese, Organic matter, Seasonal variation.

The seasonal development of the population of anoxygenic phototrophic bacteria in a holomictic stratified freshwater lake was studied and correlated with in situ-determinations of physical, chemical and biological parameters as well as with pure culture studies of the predominant species. With the onset of thermal stratification in spring, gasvacuolated phototrophic bacteria rose from the sediment concomitant to the development of the anoxic sulfide containing hypolimnion. The reducing conditions at the sediment surface led to the disintegration of aggregates which contained phototrophic bacteria and insoluble oxidized iron and manganese compounds. Mass development of phototrophic bacteria occurred at the chemocline and was mainly due to multiplication of Thiopedia rosea and Amoebobacter purpureus during summer stratification. Growth of these purple sulfur bacteria was primarily light limited. Green photosynthetic bacteria developed above (Chloronema) or under (Pelochromatium consortium) the layer of Chromatiaceae at the end of summer stratification. During fall overturn oxygenated water caused the oxidation of reduced S-, Fe-, and Mn-compounds the oxidized products of which precipitated. Phototrophic bacteria and particulate organic matter became coprecipitated with the minerals and stayed over winter at the sediment surface. (Author's abstract)
W91-04736

BASIN MORPHOLOGY IN RELATION TO CHEMICAL AND ECOLOGICAL CHARACTERISTICS OF LAKES ON THE ORINOCO RIVER FLOODPLAIN, VENEZUELA.
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.
S. K. Hamilton, and W. M. Lewis.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 393-425, October 1990. 13 fig, 9 tab, 46 ref. NSF Grants DEB8116725, BSR8315410, and BSR8604655.

Descriptors: *Flood plains, *Lake basins, *Lake morphology, *Limnology, *Orinoco River, *Venezuela, *Water chemistry, Hydrologic budget, Ions, Lake sediments, Runoff.

The relation between chemical and ecological characteristics and basin morphology in lakes on the Orinoco River floodplain of Venezuela was analyzed through measurements of dissolved oxygen, major ions, nutrients, particulates, and chlorophyll-a over an annual cycle for five lakes and upon less frequent samples from 28 lakes. Major ions served as tracers of water sources (river and local rain) to the lakes. The ratio of maximum length to maximum width was used to distinguish lakes during inundation. Channel lakes (length:width $>$ 5) have detectable currents and short water residence times; their chemistry resembles that of the source water, with little change in suspended particulates or in concentrations of labile nutrients, and negligible phytoplankton growth. Dish lakes (length:width $<$ 5) have relatively low rates of water movement and longer water residence times, and deviate in chemistry from the source water because of sedimentation of inorganic particulates, depletion of nitrate, growth of phytoplankton, and depletion of dissolved oxygen. Major ion data indicate that local rainfall was not a detectable source of water to lakes during inundation. During isolation, major ion data show a significant but variable contribution of local water (rain and runoff) to the water budget of the lakes which made prediction of lake characteristics difficult. Lake morphology (particularly the ratio of surface area to volume) was just one of several determinants of the importance of local waters to a given lake; other factors included position on the floodplain and the presence of perennial streams. In one lake for which detailed data were available, changes in the intensity of sediment resuspension during isolation were predictable from wind velocity, effective fetch, and the mean depth of the lake. (Author's abstract)
W91-04737

INFLUENCE OF CHIRONOMID LARVAE ON SEDIMENT OXYGEN MICROPROFILES.
Konstanz Univ. (Germany, F.R.). Fakultaet fuer Biologie.
P. Frenzel.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 427-437, October 1990. 6 fig, 47 ref. Deutsche Forschungsgemeinschaft Grant SFB 248.

Descriptors: *Dissolved oxygen, *Ecological effects, *Lake sediments, *Limnology, *Midges, Environmental effects, Lake Constance, Sediment-water interfaces.

Sediment microprofiles were performed at Lake Constance in the profundal zone to determine the effects of Chironomidae tunneling on sediment oxygen levels. At 4 C, larvae of Microspectra sp. showed an activity pattern with active periods of 10 to 20 minutes and resting phases of 20 to 40 minutes. Oxygen concentration in front of the tube showed large fluctuations, indicating periodic outflow of water with low oxygen concentration. In the sediment surrounding the tube fluctuations were detected in a distance up to 2.5 mm from the tube lining. In a ten minute period, conditions in the sediment surrounding a tube may shift from oxic to anoxic and vice versa. In the profundal zone of Lake Constance, abundance of larvae was too low to cause any reliable effect upon sediment water interactions, while in the littoriprofundal zone, an increase of aerobic sediment volume of 25% was possible. Such extreme chironomid densities have been reported from sediments at the inflow of large rivers, so that in these habitats exchange processes should be dominated by bioturbation. (Geiger-PTT)
W91-04738

SEASONAL DYNAMICS AND PRODUCTION OF CHIRONOMIDAE IN A LARGE LOWLAND RIVER UPSTREAM AND DOWNSTREAM FROM A NEW RESERVOIR IN CENTRAL POLAND.
Lodz Univ. (Poland). Dept. of Ecology and Vertebrate Zoology.
M. Grzybkowska, J. Hejduk, and P. Zielinski.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 439-455, October 1990. 7 fig, 3 tab, 33 ref. Institute of Ecology of the Polish Academy of Sciences CPBP 04.09.

Descriptors: *Benthos, *Dam effects, *Limnology, *Midges, *Population density, *Population dynamics, Aquatic habitats, Aquatic populations, Environmental effects, Macroinvertebrates, Poland, Reservoirs, Seasonal variation, Species composition, Species diversity, Warta River.

Benthic macroinvertebrates were investigated in one transect established above (Ta) and one downstream (Td) of a new dam reservoir constructed in a 7th stream order section of the Warta River, Poland. In both transects density was highest near the banks and decreased abruptly towards the midriver, but the transect means were similar, 1228 individuals/sq m in Ta and 1546 in Td. Chironomidae dominated, reaching 60.0% of total macrobenthos abundance in Ta and 58.6% in Td, and their species richness was higher in Ta (37 species, including 11 Orthocladiinae) than in Td (26, including 4 Orthocladiinae). Both transects were dominated by gathering collectors: Chironomini: Ch. thummi (9.2% of total macrobenthos abundance in Ta and 6.2% in Td), G. gripekoveni (12.6% and 16.7%), P. albimanus (16.7% and 14.2%), P. demeijerei (5.0% and 8.1%) and by Orthocladiinae: C. sylvestris (23.9% and 41.4%). Filtering collectors (Tanytarsini) were abundant only in Ta; P. confusus constituted 25.1% in Ta and only 1.0% in Td. The abundance of predators (Tanypodinae) was low (0.7% in Ta and 0.1% in Td). Annual production of Chironomidae larvae in both transects was similar: 2.490 g dry wt/sq m/yr in Ta and 2.970 in Td. The most productive were two large species inhabiting bands along the banks: G. gripekoveni (26.3% in Ta and 44.4% in Td) and Ch. thummi (17.1% in Ta and 7.3% in Td). (Author's abstract)
W91-04739

PROTEIN-MEDIATED SELENIUM BIOMETHYLATION IN EVAPORATION POND WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-04744

MODELING TRANSFER OF CS137 FALLOUT IN A LARGE FINNISH WATERCOURSE.
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Nuclear Engineering Lab.
For primary bibliographic entry see Field 5B.
W91-04749

WERNER SCHNESE AND THE DEVELOPMENT OF COASTAL WATERS ECOLOGY IN ROSTOCK, GDR.
Rostock Univ. (German D.R.). Dept. of Biology.
For primary bibliographic entry see Field 2L.
W91-04750

PHOSPHORUS BUDGET FOR DAL, A HIMALAYAN LAKE.
Kashmir Univ., Srinagar (India). Dept. of Botany.
M. Ishaq, and V. Kaul.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 1, p 59-69, 1990. 7 fig, 7 tab, 21 ref.

Descriptors: *Lakes, *Limnology, *Mountain lakes, *Phosphorus, *Retention time, Flushing, Hydrologic budget, Lake Dal, Lake sediments, Macrophytes, Marl.

The phosphorus budget of Dal Lake in Kashmir is described for a 12 month period. The lake is characterized by high P-loading (7.5 g/sq m/a) and had high P-retention (retention coefficient 0.320). P-loading in the lake showed a positive relationship with flushing rate and a negative relationship with P-retention. A negative relation was similarly found between flushing and P-retention in the lake. The total phosphorus budget of Dal Lake for the year 1981-1982 revealed an input of 94.22 million g, an output of 63.14 million g and a retention of 31.08 million g. High P-retention is mainly due to the marl character of the lake. Sediment holds about 99% of total P-pool in the lake whereas 1% is equally distributed between water and macrophytic compartments. Interrelations of flushing of water, P-loading and P-retention in the lake suggest some important influence of flushing on the P-balance in the lake. P alone does not seem to have any direct role in growth limitation in the lake. (Geiger-PTT)
W91-04751

SEASONAL CHANGES IN THE CHEMICAL COMPOSITION OF CERATOPHYLLUM DEMERSUM L. IN A SMALL POND.
Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip, and K. Philipp.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 1, p 71-78, 1990. 4 fig, 2 tab, 21 ref.

Descriptors: *Aquatic plants, *Carbohydrates, *Fatty acids, *Limnology, *Proteins, Macrophytes, Ponds, Seasonal variation.

Seasonal content of total soluble carbohydrate, total soluble protein, free fatty acids and alkaloids were examined in a population of Ceratophyllum demersum growing in a pond on the southwestern edge of the Canadian Shield. Total soluble carbohydrate and total soluble protein were inversely correlated. Free fatty acids were dominated by (16:0+16:1), 18:2 and 18:3. Relative proportions of the different free fatty acids remained roughly constant throughout the season. Alkaloid concentrations showed large fluctuations, with the highest values found during the first half of the season. Carbohydrate and protein contents of associated periphyton were not correlated with host macrophyte metabolism. (Author's abstract)
W91-04752

RELIABILITY OF ANALYSES OF HG, FE, CA, K, P, PH, ALKALINITY, CONDUCTIVITY, HARDNESS AND COLOUR FROM LAKES.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 5A.
W91-04753

FISH OF THE AMAZONIAN IGAPO: STABILITY AND CONSERVATION IN A HIGH DIVERSITY-LOW BIOMASS SYSTEM.
Central Electricity Generating Board, Fawley (England). Marine Biological Unit.
P. A. Henderson.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 61-66, 1990. 1 fig, 1 tab, 11 ref.

Descriptors: *Amazon River, *Aquatic habitats, *Conservation, *Fish, *Fish populations, *Forest ecosystems, *Species diversity, *Vegetation effects, Biomass, Blackwaters, Deforestation, Disturbance, Economic aspects, Evolution, Humic acids, Nutrient availability, Seasonal variation, Temporal distribution.

Water depth in the Amazon basin can differ by more than 11 m between low and high water periods in the annual cycle. When the water is high, the forest streams inundate the surrounding low-lying forest creating vast lakes. The water originates from the forest rich in humic acids and low in dissolved nutrients. Such waters are termed blackwaters. Igapo is the specialized inundation forest of blackwater regions. Until recently, blackwater fauna was considered impoverished and of low biomass. However, these forests hold a specialized fauna living within and upon allochthonous input from the forest. Within submerged litter banks a diverse ichthyofauna forming dense local populations has been found. This community is highly vulnerable to deforestation and the long-term future of the community can only be assured if the forest is conserved. These fish can adapt to disturbance, as the community has evolved to live with changing water levels and the loss of submerged wood and leaf-litter habitat. The Igapo community is a remarkable example of a climax community exhibiting high diversity and low total population sizes within a variable habitat. Its conservation is of economic importance to the local human population whose diet includes a high proportion of fish. (Author's abstract)
W91-04784

CONSERVATION STATUS OF THE NORTH AMERICAN FISH FAUNA IN FRESH WATER.
Bureau of Land Management, Washington, DC. Wildlife and Fisheries Div.
For primary bibliographic entry see Field 6G.
W91-04785

THREATENED FISHES OF BAROMBI MBO: A CRATER LAKE IN CAMEROON.
Horniman Museum, London (England).
For primary bibliographic entry see Field 8I.
W91-04791

STRUCTURE OF EPILITHON IN SOME ACIDIC AND CIRCUMNEUTRAL STREAMS IN SOUTH WESTLAND, NEW ZEALAND.
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
K. J. Collier, and M. J. Winterbourn.
New Zealand Natural Sciences NZNSEZ, Vol. 17, p 1-11, 1990. 4 fig, 47 ref.

Descriptors: *Acid rain effects, *Acid streams, *Epilithon, *Stream biota, Acidic water, Algae, Chlorophyll, Cyanophyta, Diatoms, Electron microscopy, Filamentous algae, Fragilaria, Gomphonema, New Zealand, Streams.

The composition and biomass of epilithon colonizing introduced substrata was investigated in two acid (pH 4.3-5.7), brownwater and two circumneutral (pH 6.6-8.0), clearwater streams in South Westland, New Zealand. Scanning electron microscopy showed that epilithon in the circumneutral streams was composed primarily of diatoms (mostly Gomphonema subclavatum and Achnanthes minutissima) and blue-green algae, whereas in the acid streams other species of diatoms (mainly Fragilaria and Eunotia species), filamentous algae (including Stigeoclonium sp. and Tribonema sp.) and deposits of amophous material (possibly adsorbed or precipitated organic carbon) were common. Energy-dispersive X-ray analysis indicated that silicon was the most abundant element in epilithon at all sites, presumably reflecting the presence of siliceous diatom frustules or mineral particles. Calcium was significantly more abundant (4-30 times) in epilithon from the circumneutral streams, whereas iron was significantly more common in epilithon at one of the acid, brownwater sites. The ratios of organic carbon to chlorophyll a + phaeophytin a concentration were sig-

nificantly greater at acid than circumneutral sites, indicating that algae comprised proportionately less of the epilithic carbon at the former sites. Adsorbed or precipitated organic carbon appears to be a major component of epilithon in acid, brownwater streams, whereas low algal biomass may be maintained by a combination of nutrient-limitation, growth inhibition by humic substances, and physical abrasion of stone surfaces. (Author's abstract)
W91-04812

MANAGING A LAKE FOR WATER CONTROL AND WETLANDS CREATION.
Black and Veatch, Kansas City, MO.
For primary bibliographic entry see Field 4A.
W91-04849

SUMMARY OF SELECTED CHARACTERISTICS OF LARGE RESERVOIRS IN THE UNITED STATES AND PUERTO RICO, 1988.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04862

ACUTE TEMPERATURE AND OXYGEN STRESS AMONG GENOTYPES OF DAPHNIA PULEX AND SIMOCEPHALUS VETULUS (CLADOCERA, DAPHNIIDAE) IN RELATION TO ENVIRONMENTAL CONDITIONS.
Manitoba Univ., Winnipeg. Dept. of Zoology.
S. LaBerge, and B. J. Hann.
Canadian Journal of Zoology CJZOAG, Vol. 68, No. 11, p 2257-2263, November 1990. 2 fig, 4 tab, 37 ref.

Descriptors: *Aquatic animals, *Aquatic environment, *Ecosystems, *Environmental effects, *Genetics, *Limnology, *Oxygen requirements, *Species diversity, *Temperature effects, *Waterfleas, Animal physiology, Electrophoresis, Environment, Oxygen depletion, Temporal variation, Tolerance.

The interactions among the genetics, physiology, and ecology of Daphnia pulex and Simocephalus vetulus inhabiting an ephemeral pond were investigated. Electrophoretic analysis of four loci revealed high genetic diversity and genotype existence within each species. In a total of 227 D. pulex individuals, 92 unique genotypes were found, and for 112 S. vetulus individuals, 18 unique genotypes were found. Daphnia pulex inhabited the pond early in the summer, but later S. vetulus became dominant. Biweekly sampling through the open water period allowed environmental parameters such as water temperature and oxygen saturation to be monitored, and the condition of the animals to be monitored via egg number, lipid content and ovary development, carapace length, and hemoglobin content. In laboratory experiments, S. vetulus was found to be more tolerant of high temperature and low oxygen saturation than D. pulex. In addition to these interspecific tolerance differences, there were genotypic differences within each species in temperature tolerances. The laboratory-determined genetic and physiological differences within and between species have been related to the temporal variation in environmental conditions experienced directly in the pond. Thus, the rapid changes in pond conditions appear to play a large role in determining the species and genotypes able to exist in such an unpredictable environment. (Author's abstract)
W91-04908

GROUNDWATER AND WETLAND CONTRIBUTIONS TO STREAM ACIDIFICATION: AN ISOTOPIC ANALYSIS.
Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
For primary bibliographic entry see Field 5B.
W91-04928

2I. Water In Plants

IGARSS '88. REMOTE SENSING: MOVING TOWARDS THE 21ST CENTURY.
For primary bibliographic entry see Field 7C.
W91-03944

CORRELATION OF REFLECTANCE AND CHLOROPHYLL FLUORESCENCE SIGNATURES OF HEALTHY AND DAMAGED FOREST TREES.
Karlsruhe Univ. (Germany, F.R.). Botanisches Inst. II.
For primary bibliographic entry see Field 7B.
W91-03946

CORRELATION OF RADAR REFLECTIVITY AND CHLOROPHYLL FLUORESCENCE OF FOREST TREES.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Elektrotechnische Gundlagen der Informatik.
For primary bibliographic entry see Field 7B.
W91-03947

WATER RELATIONS OF A WALNUT ORCHARD: SIMULTANEOUS MEASUREMENT WITH REMOTE SENSING.
Michigan Univ., Ann Arbor. Biological Station.
For primary bibliographic entry see Field 7B.
W91-03966

ECOLOGY AND MANAGEMENT OF WATER PLANTS IN LOWLAND STREAMS.
For primary bibliographic entry see Field 4A.
W91-03968

RELATIVE DROUGHT RESISTANCE OF TRISTANIOPSIS LAURINA AND ACMENA SMITHII FROM RIPARIAN WARM TEMPERATE RAINFOREST IN VICTORIA.
Melbourne Univ., Parkville (Australia). Dept. of Botany.
D. R. Melick.
Australian Journal of Botany AJBTAP, Vol. 38, No. 4, p 361-370, 1990. 2 fig, 2 tab, 28 ref.

Descriptors: *Australia, *Drought resistance, *Plant-water relationships, *Rain forests, *Riparian vegetation, Drought effects, Leaves, Plant physiology, Temperate zone, Wilting.

The drought tolerances of the warm temperate rainforest species Tristaniopsis laurina and Acmena smithii were examined. Using pressure bomb techniques the tissue water relations of hardened juvenile and adult material were measured. T. laurina showed relatively little physiological drought tolerance in either the juvenile or adult plants, whereas A. smithii showed an increase in physiological drought tolerance in adult plants. Direct observations of droughted hardened 9-month-old seedlings revealed a relatively high leaf conductance in T. laurina seedlings with wilting becoming generalized after 9 days of droughting. All T. laurina plants rehydrated after 15 days of drought survived albeit with significant leaf abscission, but only 2 of the 5 plants rehydrated after 20 days of drought recovered and these were defoliated. Stomatal resistances were higher in droughted A. smithii seedlings and wilting did not become generalized until after 14 days of droughting. All A. smithii plants recovered when rehydrated after 20 days of droughting with little or no sign of leaf abscission. Leaves of T. laurina and A. smithii became scorched when subjected to temperatures of 50 degrees celsius and 60 degrees celsius respectively. These differences may be very important in delimiting the distribution of these species in the relatively dry warm temperate rainforest communities of the Gippsland region in the state of Victoria, Australia. (See also W91-04055) (Author's abstract)
W91-04054

FLOOD RESISTANCE OF TRISTANIOPSIS LAURINA AND ACMENA SMITHII FROM RIPARIAN WARM TEMPERATE RAINFOREST IN VICTORIA.
Melbourne Univ., Parkville (Australia). Dept. of Botany.
D. R. Melick.
Australian Journal of Botany AJBTAP, Vol. 38, No. 4, p 371-381, 1990. 5 fig, 2 tab, 26 ref.

Descriptors: *Australia, *Flood resistance, *Plant-water relationships, *Rain forests, *Riparian vegetation, Flood damage, Light effects, Plant growth, Temperate zone, Vegetation regrowth.

The responses of seedlings of Tristaniopsis laurina and Acmena smithii, two important tree species in riparian warm temperate rainforest communities in the state of Victoria, Australia, were investigated in relation to flood disturbances. Freshly germinated A. smithii seedlings died within 5 weeks of complete waterlogging in the greenhouse, and although the young T. laurina seedlings survived waterlogging for 14 weeks, their growth rate was curtailed. Nine-month-old seedlings of both species were found to be relatively tolerant to waterlogging, forming aerenchymatous surface roots after 40 days of flooding. Neither species suffered leaf abscission or demonstrated any other signs of water stress commonly associated with flood intolerant species. In experiments to determine the resilience of these species to physical flood damage, both species also demonstrated a capacity to regenerate vegetatively following the removal of aboveground parts in young seedlings. The heartwood of T. laurina was found to be more decay resistant than that of other species in the field including that of A. smithii. T. laurina is well adapted to flood regimes, requiring moist, relatively high-light environments for seedling growth and development; thus, it is restricted to flood-disturbed environments within the rainforest. However, A. smithii, although able to survive flood disturbance is also capable of regeneration within an undisturbed rainforest away from riparian sites due to its greater drought and shade tolerance. (See also W91-04054) (Fleishman-PTT)
W91-04055

COMMUNITY PATTERNS AND ENVIRONMENTAL GRADIENTS OF BUTTONBUSH, CEPHALANTHUS OCCIDENTALIS, PONDS IN LOWLAND FORESTS OF SOUTHERN ONTARIO.
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
D. Faber-Langendoen, and P. F. Maycock.
Canadian Field-Naturalist CAFNAK, Vol. 103, No. 4, p 479-485, October/December 1989. 3 fig, 3 tab, 17 ref.

Descriptors: *Environmental gradient, *Forest ecosystems, *Limnology, *Ontario, *Plant-water relationships, *Ponds, *Wetlands, Ecological distribution, Emergent aquatic plants, Flooding, Species composition, Species diversity.

Ten buttonbush (Cephalanthus occidentalis) ponds in two lowland forests of southern Ontario were sampled for plant composition and environmental factors. Species presence was recorded in four zones: forest, mound, platform, and emergent. Water fluctuations were measured for 2 years. Species distributions across zones within sites (coarse-scale gradient) were limited by steep environmental gradients related to permanent inundation and presence or absence of flooding between the pond and forest floor. Cephalanthus occidentalis, Fraxinus pennsylvanica (green ash), Ulmus americana (American elm), and Acer saccharinum (silver maple) were the only woody taxa more common in the platform than in the forest zone. Cephalanthus was restricted primarily to the platform and emergent zones. Species richness declined from forest to emergent zone. Species distributions between ponds for the platform zone only (fine-scale gradient) were analyzed by detrended correspondence analysis. The primary compositional gradient was correlated with variation in water fluctuations, pond size, and soil moisture. Abundance patterns for Cephalanthus, however, were influenced by another factor: water depth. These analyses suggest how two scales of environmental gradients influence species distributions within buttonbush ponds; the zonal coarse-scale gradient caused by flooded/not flooded conditions, and the fine-scale continuous gradient caused by

variations between ponds in water fluctuation within a zone. (Author's abstract)
W91-04056

RAINFALL INTERCEPTION IN TWO TROPICAL MONTANE RAIN FORESTS, COLOMBIA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.
E. J. Veneklaas, and R. Van Ek.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 311-326, October/December 1990. 10 fig, 4 tab, 32 ref. Netherlands Foundation for the Advancement of Tropical Research W84-236.

Descriptors: *Colombia, *Interception, *Rain forests, *Storage capacity, *Tropical regions, Andes Mountains, Canopy, Epiphytes, Evaporation, Hydrologic budget, Mountains, Rainfall distribution.

Rainfall interception was studied during one complete year in two montane rain forests in the Colombian Andes at altitudes of 2550 and 3370 m. Additional measurements were made in a subsequent period at 3370 m, comparing two plots with different tree genera. Special attention was paid to the possible consequences of the abundant epiphytic vegetation, representing a high but spatially variable storage capacity. On an annual basis, interception amounted to 262 mm (12.4%) of 2115 mm incident precipitation at 2550 m, and to 265 mm (18.3%) of 1453 mm incident precipitation at 3370 m. There was no evidence for fog precipitation. The fact that, in spite of lower annual rainfall and lower evaporation rate, absolute quantity of interception at 3370 m was not lower than at 2440 m is probably related to differences in rainfall distribution and canopy storage capacities. The different responses of the two tree genera (characterized by distinct epiphyte cover) and the lower interception after prolonged wet periods support the idea that epiphytes play a significant role in the interception process. A realistic description of the water balance of such ecosystems will require the adaptation of existing interception models. (Author's abstract)
W91-04101

NATURAL CONSUMPTIVE USE BY TULES, GRASSLANDS, AND RIPARIAN FORESTS, CALIFORNIA CENTRAL VALLEY.
D. R. Dawdy.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 621-631, 1 fig, 7 tab, 27 ref.

Descriptors: *California, *Consumptive use, *Environmental effects, *Land use, *Plant-water relationships, *Water resources development, *Water use, *Water use data, Grasslands, Riparian vegetation, River flow, Runoff, San Francisco Bay, Water loss.

The California State Water Resources Control Board is conducting hearings to set quantity and quality standards for river flows into San Francisco Bay. Comparisons of present conditions with 'natural conditions' prior to European settlement were introduced into the hearings. Consumptive use relations were developed for various riparian and water-related plants, and estimates of the total annual volume of runoff production and consumptive use were developed. Consumptive losses under natural conditions in the Central Valley of California were on the order of 11 to 15 million acre-feet/year with an average net outflow on the order of the magnitude of the unimpaired flow. The phase has shifted from the natural to the unimpaired condition with elimination of natural storage in the system. Development of the basin has reduced outflows to the Bay, and further development will reduce the flows even more. (See also W91-04161) (Lantz-PTT)
W91-04227

MONITORING MOISTURE STORAGE IN TREES USING TIME DOMAIN REFLECTOMETRY.
Geological Survey, Menlo Park, CA.
J. Constantz, and F. Murphy.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 31-42, November 1990. 7 fig, 1 tab, 17 ref.

Descriptors: *Instrumentation, *Measuring instruments, *Plant-water relationships, *Trees, California, Monitoring, On-site tests, Performance evaluation, Soil water, Time domain reflectometry, Walnut trees, Water storage.

Laboratory and field tests were performed to examine the feasibility of using time domain reflectrometry (TDR) to monitor changes in the moisture storage of the woody parts of trees. To serve as wave guides for the TDR signal, pairs of stainless steel rods (13 cm long, 0.32 cm in diameter, and 2.5 cm separation) were driven into parallel pilot holes drilled into the woody parts of trees, and a cable testing oscilloscope was used to determine the apparent dielectric constant. A calibration curve was developed and used to estimate the volumetric water content to a dept of 13 cm in living trees. One field experiment was conducted on an English walnut tree (Juglans regia) with a diameter of 40 cm, growing in a flood-irrigated orchard on a Hanford sandy loam near Modesto, California. The moisture content determined by TDR showed a gradual decrease from 0.44 to 0.42 cu cm/cu cm over a 2-wk period prior to flood irrigation, followed by a rapid rise to 0.47 cu cm/cu cm over a 4-day period after irrigation, then again a gradual decline approaching the next irrigation. A second field experiment was made on 10 evergreen and deciduous trees with diameters ranging from 30 to 120 cm, growing in the foothills of the Coast Range of central California. Most trees showed an early spring maximum in moisture content determined by TDR associated with leaf growth, and a late summer minimum in moisture content associated with the end of the dry season. Moisture contents ranged from 0.20 to 0.70 cu cm/cu cm, with an annual percentage change in moisture of 15-70% depending on species and environmental conditions. A final field test was performed in northern New Mexico to examine the effect of trunk freezing on TDR measurements. This test confirmed that freezing conditions were recorded as a total loss of liquid water by the TDR method. These results suggest that further TDR calibration of wood, plus some understanding of the relation between tree moisture and physiological stress, could be useful to several disciplines, ranging from irrigation scheduling to watershed management to forest ecology. (Author's abstract)
W91-04388

RESPONSE OF YELLOW-POPLAR (LIRIODENDRON TULIPIFERA L.) SEEDLINGS TO SIMULATED ACID RAIN AND OZONE--2. EFFECT ON THROUGHFALL CHEMISTRY AND NUTRIENTS IN THE LEAVES.
Northeastern Forest Experiment Station, Delaware, OH.
G. A. Schier.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 325-331, July 1990. 6 tab, 17 ref.

Descriptors: *Acid rain effects, *Nutrition, *Ozone, *Throughfall, *Water chemistry, *Yellow poplar, Hydrogen ion concentration, Iron, Leaching, Manganese, Plant metabolism, Plant physiology, Zinc.

Each week 1-year-old yellow-poplar seedlings grown in a greenhouse were fumigated with 0.0, 0.05, 0.1, or 0.2 microl/L ozone for 8 hours on 3 consecutive days and treated once with 1.25 cm simulated acid rain of pH 5.5, 4.0, and 3.0. Effects of ozone and acid rain on throughfall chemistry after 16 weeks of treatment and on mineral elements in the foliage of seedlings harvested on September 1 were determined. Except for potassium, the concentration of elements detected in throughfall (potassium, calcium, magnesium, iron and zinc) grew with increasing acidity of the rain solution. Foliar leaching of mineral elements by pH 3.0 rain was increased by high levels of ozone. The concentration of most elements in yellow-poplar leaves was affected by ozone or rain acidity. Rains of high acidity (<pH 5.5) increased the concentrations of nitrogen, potassium, phosphorus, calcium and manganese in seedling leaves. Ozone treatment increased the concentration of manganese, iron, and zinc. The concentration of manganese showed the greatest response to treatment with ozone or acid rain. (Author's abstract)
W91-04451

FOLIAR RETENTION OF 15-N-NITRATE AND 15-N-AMMONIUM BY RED MAPLE (ACER RUBRUM) AND WHITE OAK (QUERCUS ALBA) LEAVES FROM SIMULATED RAIN.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W91-04452

ARTIFICIAL SEDIMENTS FOR USE IN TESTS WITH WETLAND PLANTS.
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
For primary bibliographic entry see Field 2J.
W91-04453

ESTIMATION OF TRANSPIRATION BY SINGLE TREES: COMPARISON OF A VENTILATED CHAMBER, LEAF ENERGY BUDGETS AND A COMBINATION EQUATION.
Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Div. of Forestry and Forest Products.
For primary bibliographic entry see Field 2D.
W91-04484

STOMATAL RESISTANCE MODEL ILLUSTRATING PLANT VS. EXTERNAL CONTROL OF TRANSPIRATION.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2D.
W91-04489

REMOTE ESTIMATION OF SOIL MOISTURE AVAILABILITY AND FRACTIONAL VEGETATION COVER FOR AGRICULTURAL FIELDS.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2G.
W91-04491

AQUA, A MODEL TO EVALUATE WATER DEFICITS AND EXCESSES IN TROPICAL CROPPING: PART II. REGIONAL YIELD PREDICTION.
Costa Rica Univ., San Jose. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-04494

PRECIPITATION AND TEMPERATURE REGIMES IN UPLAND BALOCHISTAN: THEIR INFLUENCE ON RAIN-FED CROP PRODUCTION.
International Center for Agricultural Research in the Dry Areas.
For primary bibliographic entry see Field 3F.
W91-04498

CARBON DIOXIDE AND WATER LEVEL EFFECTS ON YIELD AND WATER USE OF WINTER WHEAT.
Kansas State Univ., Manhattan. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W91-04499

WATER USE BY MONOCROPPED AND INTERCROPPED COWPEA AND SORGHUM GROWN AFTER RICE.
Oregon State Univ., Corvallis. Dept. of Soil Science.
For primary bibliographic entry see Field 3F.
W91-04500

LINE-SOURCE VS. IRRIGATED/NONIRRIGATED TREATMENTS FOR EVALUATION OF GENOTYPE DROUGHT RESPONSE.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). Cereals Program.
For primary bibliographic entry see Field 3F.
W91-04501

ROOT ZONE WATER BALANCES OF THREE LOW-INPUT MILLET FIELDS IN NIGER, WEST AFRICA.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 3F.
W91-04504

CANOPY TEMPERATURE AND STOMATAL CONDUCTANCE OF WATER-STRESSED DORMANT AND NONDORMANT ALFALFA TYPES.
For primary bibliographic entry see Field 3F.
W91-04507

GROWTH RESPONSES, ION RELATIONS, AND OSMOTIC ADAPTATIONS OF ELEVEN C4 TURFGRASSES TO SALINITY.
Hawaii Univ., Honolulu. Dept. of Horticulture.
For primary bibliographic entry see Field 3C.
W91-04508

EFFECT OF TILLAGE ON SOIL WATER AND ALFALFA ESTABLISHMENT IN CORN STUBBLE.
For primary bibliographic entry see Field 3F.
W91-04537

EFFECTS OF NITROGEN AND WATER MANAGEMENT PRACTICES ON YIELD, GRAIN QUALITY, AND MILLING OUT-TURN OF RICE.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 3F.
W91-04538

GROWTH RESPONSE OF PHASEOLUS VULGARIS TO VARYING SALINITY REGIMES.
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
For primary bibliographic entry see Field 3C.
W91-04559

EFFECT OF SIMULATED ACIDIC FOG ON CARBOHYDRATE LEACHING, CO2 ASSIMILATION AND DEVELOPMENT OF DAMAGE SYMPTOMS IN YOUNG SPRUCE TREES (PICEA ABIES L. KARST).
Giessen Univ. (Germany, F.R.). Inst. of Plant Nutrition.
For primary bibliographic entry see Field 5C.
W91-04560

EFFECTS OF IRRIGATION REGIMES ON YIELD AND WATER USE BY SWEETPOTATO.
Georgia Coastal Plain Experiment Station, Tifton.
For primary bibliographic entry see Field 3F.
W91-04564

RESPONSE OF SEED CARROT TO VARIOUS WATER REGIMES: I. VEGETATIVE GROWTH AND PLANT WATER RELATIONS.
Agricultural Research Service, Fresno, CA. Water Management Research Lab.
R. B. Hutmacher, J. J. Steiner, J. E. Ayars, A. B. Mantel, and S. S. Vail.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 5, p 715-721, September 1990. 6 fig, 5 tab, 14 ref.

Descriptors: *Carrots, *Irrigation requirements, *Plant growth, *Seeds, *Soil moisture deficiency, *Soil-water-plant relationships, Crop yield, Drought effects, Evapotranspiration, Hydrological regime, Leaves, Loam, Moisture tension, Roots, Sand, Soil water, Water stress.

Regions for successful production of carrot seed are generally restricted to those with negligible summer rainfall to provide acceptable drying conditions for the seed before harvest. The influence of irrigation frequency and the severity and rate of development of soil water deficits on the vegetative growth and water status of carrots (Daucus carota L. var. sativa DC.) grown for seed were investigated in a fine sandy loam soil. Beginning with the period of rapid development of primary umbels, various irrigation frequencies (daily vs. intervals corresponding to 30 mm of accumulated crop evapotranspiration (ET)) were investigated at irrigation rates ranging from 40% to 120% of estimated ET. The magnitude and rate of development of soil water deficits markedly influenced carrot responses to developing water deficits. Stomatal conductance and leaf water potential measurements exhibited some potential for use in irrigation scheduling and were the most sensitive and consistent indicators of plant water status. Under low-frequency continuous-deficit irrigation, a combination of moderate reductions in stomatal conductance and major reductions in peak leaf area and late-season maintenance of viable leaf area occurred. These responses were effective water-conserving mechanisms, allowing growth at a reduced rate and continued development of viable seed. In contrast, rapid development of soil water deficits resulted in nearly complete stomatal closure, cessation of growth, and rapid reductions in leaf area. (See also W91-04566) (Author's abstract)
W91-04565

RESPONSE OF SEED CARROT TO VARIOUS WATER REGIMES: II. REPRODUCTIVE DEVELOPMENT, SEED YIELD, AND SEED QUALITY.
National Forage Seed Production Research Center, Corvallis, OR.
For primary bibliographic entry see Field 3F.
W91-04566

YIELD OF SUCCESSIVELY CROPPED POLYETHYLENE-MULCHED VEGETABLES AS AFFECTED BY IRRIGATION METHOD AND FERTILIZATION MANAGEMENT.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 3F.
W91-04567

2J. Erosion and Sedimentation

QUANTITATIVE REMOTE DETECTION OF SUSPENDED SEDIMENT CONTENT AND CHLOROPHYLL CONCENTRATION OF WATER IN DIFFERENT DEPTHS.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 7B.
W91-03949

IMPACT OF MULTIVIEWING REFLECTANCE DATA ON THE ESTIMATION OF SUSPENDED SEDIMENT CONCENTRATION.
Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
For primary bibliographic entry see Field 7B.
W91-03951

MONITORING OF SUSPENDED SEDIMENTS IN JATILUHUR RESERVOIR USING SATELLITE IMAGES.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
For primary bibliographic entry see Field 7B.
W91-03954

WETLAND SOIL FORMATION IN THE RAPIDLY SUBSIDING MISSISSIPPI RIVER DELTAIC PLAIN: MINERAL AND ORGANIC MATTER RELATIONSHIPS.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2L.
W91-03978

DISSOLUTION OF FELDSPARS IN THE PRESENCE OF NATURAL, ORGANIC SOLUTES.
Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.
U. Lundstrom, and L.-O. Ohman.
Journal of Soil Science JSSCAH, Vol. 41, No. 3, p 359-369, September 1990. 5 fig, 4 tab, 26 ref.

Descriptors: *Acid rain, *Acid rain effects, *Dissolution, *Feldspar, *Hydrogen ion concentration, *Organic compounds, *Solutes, *Weathering, Acid precipitation, Acidification, Groundwater, Microorganisms, Plant growth, Silt, Soil chemistry, Soil genesis, Soil water, Streamflow, Suspended solids, Temporal distribution.

Chemical weathering is the only long-term soil process, apart from transitory reduction processes, by which hydrogen ions emanating from growing plants or from acid precipitation can be neutralized. The rate at which a soil is weathered determines its sensitivity to acidification. The dissolution rates of feldspars in the presence of naturally occurring organic solutes were compared at pH 5.1. Natural silt or ground feldspar minerals were suspended in water, stream water, soil water, water extracts of peat and mor and a citrate solution for approximately 100 days. The increase of major cations and silicic acid in the aqueous phase was determined by periodic sampling and rates of dissolution were calculated when concentration increased linearly with time. The dissolution rate for the major cations was 2.7 +/-0.9 (n=3) times greater for stream water and 2.4 +/-0.4 (n=5) times greater for mor and peat extract than for distilled water. For citrate, the rate was greater by 1.7 +/-0.3 (n=3) times. By inoculating the suspensions with microorganisms weathering rates decreased to the value for distilled water, suggesting that the microorganisms consumed some active fraction of the organic solutes. (Author's abstract)
W91-03986

SOIL ORGANIC MATTER, AIR ENCAPSULATION AND WATER-STABLE AGGREGATION.
Sydney Univ. (Australia). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-03988

DYNAMIC BEHAVIOR OF SUSPENDED SEDIMENT CONCENTRATIONS IN A SHALLOW LAKE PERTURBED BY EPISODIC WIND EVENTS.
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.
For primary bibliographic entry see Field 2H.
W91-03997

DENITRIFICATION AND PHOTOSYNTHESIS IN STREAM SEDIMENT STUDIED WITH MICROSENSOR AND WHOLE-CORE TECHNIQUES.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2H.
W91-03999

COLLECTION AND ANALYSIS OF COLLOIDAL PARTICLES TRANSPORTED IN THE MISSISSIPPI RIVER, U.S.A.
Geological Survey, San Diego, CA.
For primary bibliographic entry see Field 5B.
W91-04030

MODELING OF STRONTIUM SORPTION AND SPECIATION IN A NATURAL SEDIMENT-GROUNDWATER SYSTEM.
Technische Univ. Muenchen, Garching (Germany, F.R.). Lehrstuhl und Inst. fuer Radiochemie.
For primary bibliographic entry see Field 5B.
W91-04032

SORPTION OF N-HETEROCYCLIC COMPOUNDS ON REFERENCE AND SUBSURFACE SMECTITE CLAY ISOLATES.

Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W91-04033

THICK AND FAST: SEDIMENTATION IN A PLEISTOCENE FIORD LAKE OF BRITISH COLUMBIA, CANADA.
Toronto Univ. (Ontario). Dept. of Geology.
N. Eyles, H. T. Mullins, and A. C. Hine.
Geology GLGYBA, Vol. 18, No. 11, p 1153-1157, November 1990. 4 fig, 21 ref.

Descriptors: *Canada, *Fjords, *Geohydrology, *Glaciohydrology, *Lake sediments, *Paleohydrology, *Sedimentation, Geologic history, Glacial sediments, Glaciation, Lake basins, Seismic exploration, Snowmelt.

The central interior plateau of British Columbia, Canada, is dissected by numerous elongate, glacially overdeepened lake basins akin to coastal fjords. An air-gun seismic-reflection investigation (242 km of trackline) of Okanagan Lake (120 km long, 3.5 km wide) shows that the Pleistocene sediment fill is up to 792 m thick and that bedrock has been excavated by repeated Pleistocene glacial erosion to nearly 650 m below sea level. The depth of bedrock incision below the surrounding plateau is more than 2000 m, exceeding that of the Grand Canyon in Arizona. The total volume of sediment infill within the narrow trenchlike basin is more than 90 cu km, and several lines of evidence suggest that this fill accumulated rapidly during a single phase of glaciolacustrine sedimentation during late Wisconsin deglaciation of the region after 15 ka. Similar fjord-lake basins, up to 100 km long, are common in the interior of British Columbia. If the data from Okanagan are representative, these basins may represent a major previously unrecognized component of the total glacial sediment flux to the ocean. Overdeepening below sea level and the focusing of large volumes of glacial sediment and meltwater into such basins are of considerable glaciologic significance and may record the fast, unstable flow of 'ice streams' during deglaciation of the Cordilleran ice sheet. (Author's abstract)
W91-04110

ASSESSMENT OF RUNOFF AND SUSPENDED SEDIMENT YIELD IN A PARTIALLY FORESTED CATCHMENT IN SOUTHERN CHILE.
Universidad Austral de Chile, Valdivia. Inst. de Manajo Forestal.
For primary bibliographic entry see Field 4C.
W91-04118

AT-A-POINT BED LOAD SAMPLING IN THE PRESENCE OF DUNES.
Indiana State Univ., Terre Haute. Dept. of Geography and Geology.
B. Gomez, D. W. Hubbell, and H. H. Stevens.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2717-2731, November 1990. 13 fig, 5 tab, 33 ref.

Descriptors: *Bed load, *Bottom sampling, *Data acquisition, *Dunes, *Sampling, *Sediment transport, *Streambeds, Bed-load discharge, Streamflow, Streamflow data.

Even during constant, or virtually constant, flow conditions, bed load transport rates are known to vary over a range of temporal scales. Previous studies have emphasized that in order to provide an accurate estimate of the mean bed load transport rate at a given point, either many samples must be collected repeatedly or the sampling time must be long. Errors associated with at-a-point bed load sampling during steady flow conditions in the presence of dunes were systematically evaluated and provided as an indication of the way in which sampling should proceed in order to minimize sampling errors. The analysis was undertaken using laboratory data and a theoretical probability distribution function. It assumed that bed load samplers had an efficiency of 100% and that the flow conditions and the configuration of the primary bed forms remained constant during the sampling period. In the presence of dunes, sampling should be accomplished using: (1) the shortest practicable sampling time for each sample, (2) short, equally spaced time intervals between samples, and (3) as long a sampling period as is necessary to ensure that at least one primary bed form has passed the sampling point. Such procedures will provide information about high and low-frequency fluctuations in at-a-point bed load transport rates and a reasonably reliable estimate of the mean bed load transport rate. Only about 21 sequential samples were required to estimate the mean bed load transport rate at any given point. However, because the sampling time generally was short in comparison with the time that it takes a dune to pass the sampling point, between 50 and 100 samples were needed to define both high and low-frequency at-a-point rate variations. A knowledge of the prevailing bed configuration was necessary in order to ensure that sampling proceeded in accordance with these requirements. (Author's abstract)
W91-04125

IRON TRANSPORT AND DISTRIBUTION BETWEEN FRESHWATER AND SEDIMENTS OVER DIFFERENT TIME SCALES.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 2H.
W91-04154

OXIDATION AND REDUCTION OF RADIO-LABELED INORGANIC SULFUR COMPOUNDS IN AN ESTUARINE SEDIMENT, KYSING FJORD, DENMARK.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2K.
W91-04155

TRACE METAL IONS IN GANGA WATER SYSTEM.
Industrial Toxicology Research Centre, Lucknow (India).
For primary bibliographic entry see Field 2K.
W91-04259

SETTLING SPEED OF FLOCS IN FRESH WATER AND SEAWATER.
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
P. Y. Burban, Y. J. Xu, J. McNeil, and W. Lick.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 10, p 18,213-18,220, October 15, 1990. 5 fig, 1 tab, 25 ref.

Descriptors: *Flocculation, *Freshwater, *Seawater, *Sedimentation, *Sedimentation rates, Aggregates, Particle size, River sediments, Salinity, Sediment concentration.

The settling speeds of flocs of fine-grained, natural sediments approximately 10-200 micron in diameter have been measured in both freshwater and seawater. These flocs were formed at fluid shears of 100, 200, and 400 per second and at sediment concentrations of 10, 100, and 400 mg/L, values typical of conditions in the near-shore areas of lakes and oceans, especially during storm conditions. It was demonstrated that he settling speed of a floc is a strong function of fluid shear and sediment concentration as well as of the diameter of the floc, but is a weak function of salinity. For the same diameter and salinity, flocs produced at the lower fluid shears and sediment concentrations have lower settling speeds than do flocs produced at higher fluid shears and sediment concentrations. If the conditions of fluid shear and sediment concentration under which the flocs were produced are unknown or ignored, it was shown that the settling speed of a floc is a weak function of diameter and salinity. (Author's abstract)
W91-04296

NEW NUMERICAL/PHYSICAL FRAMEWORK FOR MOBILE-BED MODELLING, PART I: NUMERICAL AND PHYSICAL PRINCIPLES.
Iowa Univ., Iowa City.
F. M. Holly, and J. L. Rahuel.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 401-416, 1990. 1 fig, 30 ref. NSF Grant MSM-85-18166.

Descriptors: *Alluvial channels, *Bed load, *Channel morphology, *Model studies, *River beds, *Sediment transport, Flow equations, Flow models, Hydraulics, Mobile beds, River flow, Sediment load, Simulation analysis, St Venant equation.

A new computational framework for one-dimensional simulation of the long-term evolution of alluvial rivers in response to hydraulic, hydrologic, and sedimentary perturbations (mobile bed simulation) has been developed. The approach is based on use of the full de St. Venant flow equations, treatment of sediment mixtures, recognition of the distinctly different physics of suspended load and bedload movement, use of a spatial-delay loading law for bedload, and fully coupled, implicit numerical solution of the resulting set of partial-differential equations. In eliminating most of the conceptual and numerical weaknesses of existing methods, the new approach establishes a new standard of fidelity to the governing conservation laws, whatever be the particular empirical sediment relations employed for a particular application. The method is a generic one, intended for use with the particular empirical relations that are most appropriate for processes such as suspended-load entrainment, alluvial roughness, bedload equilibrium capacity, or hiding factor. (MacKeen-PTT)
W91-04303

SURFACE-BASED BEDLOAD TRANSPORT RELATION FOR GRAVEL RIVERS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
G. Parker.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 417-436, 1990. 8 fig, 1 tab, 33 ref.

Descriptors: *Bed load, *Gravel, *Model studies, *River sediments, *Sediment transport, Gravel rivers, Particle size, River beds, Sediment load, Sediment yield.

Bedload transport in gravel-bed rivers is accomplished by means of the mobilization of grains exposed on the bed surface. This mobilization is due to the action of fluid forces on the exposed grains. Substrate particles can participate in the bedload only to the extent that local or global scour results in their exposure on the surface. It follows that a calculation of the bedload transport rate of mixtures should be based on the availability of each size range in the surface layer. An existing substrate-based gravel transport relation was transformed into a surface-based relation. Implicit in the transformation is the concept of hiding, according to which coarser surface grains are intrinsically less mobile than finer surface grains. The quantification of hiding allows for differential transport of grains of varying sizes, and at the same time allows for the formation of a mobile armor. The surface-based relation can be expected to apply to both equilibrium and disequilibrium conditions, as long as the time and length scales of the disequilibrium are large compared to the time (length) required for gravel to respond to altered bed shear stress. In the limit of uniform material, the relation reduces to a plausible form that compares well with existing relations. The proposed relation has the advantage of being based solely on field data for gravel rivers. (MacKeen-PTT)
W91-04304

EXPERIMENTAL STUDY OF THE EFFECT OF BED GRAIN ROUGHNESS ON SEDIMENT SORTING BY ENTRAINMENT.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
C. S. James, G. Lymberopoulos, and P. Scalla.
Water SA WASADV, Vol. 16, No. 4, p 257-264, October 1990. 12 fig, 2 tab, 7 ref.

Descriptors: *Bed load, *Entrainment, *Hydraulic roughness, *Sediment sorting, *Sediment transport, *Sediments, Bed grain roughness, Experi-

mental data, Flow velocity, Particle size, Shear stress.

A series of experiments was conducted to investigate the effect of bed grain roughness on the sorting of mixed-size sediments during entrainment. Loose sediments were entrained off stabilized beds with different roughness and the masses and size characteristics of the permanently trapped material was analyzed. Entrainment of sediment from a rough bed increased with increasing flow velocity or bed shear stress and decreased with increasing bed roughness. The dependence on these factors decreased as the sediment size increased relative to the bed roughness. The shape of the bed roughness elements had a significant effect on entrainment, with increased angularity inhibiting entrainment. Significant sorting by size occurred during entrainment. Generally, the coarser grains in the mixtures tested were more easily entrained than the finer ones, a tendency which increased with decreasing bed roughness. Under certain conditions intermediate sizes were more easily entrained than both finer and coarser ones, suggesting that entrainment sorting could be a cause of the bimodal fluvial sediments common in nature. (MacKeen-PTT)
W91-04316

SEDIMENT IN SEWERS: INITIATION OF TRANSPORT.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04351

SEWER SEDIMENT AND ITS RELATION WITH THE QUALITY CHARACTERISTICS OF COMBINED SEWER FLOWS.
Universite Libre de Bruxelles (Belgium). Lab. de Traitement des Eaux et Pollution.
For primary bibliographic entry see Field 5D.
W91-04352

SEDIMENT MOVEMENT INTO THE COMBINED TRUNK SEWER NO. 13 IN MARSEILLE.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
For primary bibliographic entry see Field 5D.
W91-04353

SEDIMENT MOVEMENT IN COMBINED SEWERS IN DUNDEE.
Dundee Coll. of Technology (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04358

PARTITIONING OF UNSUBSTITUTED POLYCYCLIC AROMATIC HYDROCARBONS BETWEEN SURFACE SEDIMENTS AND THE WATER COLUMN IN THE BRISBANE RIVER ESTUARY.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 5B.
W91-04361

ESTUARY SEDIMENTS OF THE YOSHINO RIVER–STUDY ON ESTUARY SEDIMENTS, PART 2.
Kochi Univ. (Japan). Dept. of Geology.
For primary bibliographic entry see Field 2L.
W91-04439

ARTIFICIAL SEDIMENTS FOR USE IN TESTS WITH WETLAND PLANTS.
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Environmental Research Lab.
G. E. Walsh, D. E. Weber, L. K. Brashers, and T. L. Simon.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 391-396, July 1990. 6 tab, 21 ref.

Descriptors: *Aquatic plants, *Plant growth, *Sediments, *Wetlands, Cations, Grain size, Microorganisms, Sediment chemistry.

Artificial sediments are described for use in studies on rooted marsh plants. The sediments, which are similar in particle size distribution to natural sediments, are formulated from commercially available sand, silt, clay and organic matter. Average survival rates of seedlings of Echinochloa crusgalli var crusgalli, Scirpus paludosus and Spartina alterniflora were 93.4%,, 90.4% and 89.4%, respectively. Average seedling weight of each species was unaffected by percentage sand, silt, clay, organic matter, pH or cation exchange capacity except for Scirpus paludosus, which required organic matter in the sediment for maximal growth and whose growth was affected by the relationship between particle size and percentage sand. These formulations have advantages over commercial potting mixes and other plant growth media because they allow design of well-defined sediments for specific purposes. The artificial formulations also do not have the disadvantages of natural sediments which may change drastically during a test, may contain toxic chemicals, weed seeds, or undesirable microbes and animals, and which may not be of desirable composition. (Brunone-PTT)
W91-04453

TIDAL VELOCITY ASYMMETRIES AND BEDLOAD TRANSPORT IN SHALLOW EMBAYMENTS.
Woods Hole Oceanographic Institution, MA.
V. A. Fry, and D. G. Aubrey.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 5, p 453-473, May 1990. 12 fig, 1 tab, 18 ref.

Descriptors: *Bays, *Bed load, *Mathematical models, *Sediment transport, *Tidal currents, Channels, Embayments, Finite difference methods, Numerical analysis, Shallow water.

Tidal circulation can cause a net transport of sediment when the tidal velocity is asymmetric about a zero mean (flood or ebb dominant) and the sediment transport rate is related nonlinearly to velocity. The relationship between tidal elevation and velocity permits determination from tidal gauge data and sediment transport relations whether tidal asymmetry needs to be considered as a mechanism for net sediment transport in the embayment of interest. A relationship between elevation and velocity in a shallow water, nonlinear system is derived through the continuity equation and shown to be significantly different than the linear relation. Finite difference numerical solutions of the one-dimensional, shallow water nonlinear equations are compared to the continuity relation and are in agreement especially toward the landward end of the channel. Tide gauge data collected at the landward end of the embayment are most useful for predicting velocity asymmetries throughout a major portion of the embayment channel. The ratio of flood-to-ebb bedload transport and its relation to an asymmetric tidal elevation has been determined for both the linear relation between elevation and velocity and the nonlinear relation. Results show that the ratio of flood-to-ebb bedload transport as calculated from the nonlinear relation between elevation and velocity is similar to the flood-to-ebb ratio calculated from the linear relation because of offsetting effects. (Author's abstract)
W91-04459

DISTRIBUTION AND COMPOSITION OF SUSPENDED PARTICULATE MATERIAL IN THE CLYDE ESTUARY AND ASSOCIATED SEA LOCHS.
Marine Lab., Aberdeen (Scotland).
For primary bibliographic entry see Field 2L.
W91-04460

INFLUENCE OF PIG FARMING ON THE COPPER CONTENT OF ESTUARINE SEDIMENTS IN BRITTANY, FRANCE.
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest. Dept. Environnement Littoral.
For primary bibliographic entry see Field 5B.
W91-04515

CU AND CD ASSOCIATED WITH SUSPENDED PARTICULATE MATTER IN TORRES STRAIT.
Sydney Univ. (Australia). Ocean Sciences Inst.
For primary bibliographic entry see Field 5B.
W91-04524

GUELPH RAINFALL SIMULATOR II: PART 1. SIMULATED RAINFALL CHARACTERISTICS.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 2B.
W91-04547

GUELPH RAINFALL SIMULATOR II: PART 2. A COMPARISON OF NATURAL AND SIMULATED RAINFALL CHARACTERISTICS.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 2B.
W91-04548

EFFECTS OF POTATO CROPPING PRACTICES ON WATER RUNOFF AND SOIL EROSION.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
T. L. Chow, J. L. Daigle, I. Ghanem, and H. Cormier.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 2, p 137-148, May 1990. 6 fig, 2 tab, 19 ref.

Descriptors: *Agricultural practices, *Agricultural runoff, *Canada, *Planting management, *Soil erosion, *Surface runoff, *Surface water, Clovers, Cropland, Erodibility, Fallowing, Farm management, New Brunswick, Potatoes, Slope effects, Slope stability, Soil conservation, Soil management, Universal soil loss equation.

Accelerated soil erosion by water is the most severe and widespread soil degradation problem in the Maritime provinces of Canada. It constitutes a serious potential problem on most agricultural lands if they are planted by row crops. Using runoff-erosion plots (10 m wide x 30 m long), the effects of cropping practices on surface runoff and soil loss were examined on a Hommesville gravelly loam soil to evaluate the applicability of the Universal Soil Loss Equation in New Brunswick, Canada. The amount of water runoff and soil loss from continuous fallow, up-and-down slope planting of potatoes (Solanum tuberosum), and clover (Trifolium pratense) on 8 and 11% slopes were measured from 1983 to 1985. In addition, runoff and soil loss from contour planting of potatoes were measured on the 11% slope. Slope planting of potatoes resulted in higher runoff and soil loss than on fallow plots. There was considerable reduction in runoff and soil loss when potatoes were planted along the contour. Runoff and soil loss under clover were negligible. Rainfall erosion index and slope length and steepness correlated well with the measured soil losses. However, both the measured soil erodibility factor and the cover and management factor deviated markedly from the current values used for conservation planning. (Author's abstract)
W91-04552

BIOACCUMULATION BIOASSAY FOR FRESHWATER SEDIMENTS.
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
For primary bibliographic entry see Field 5A.
W91-04630

INFLUENCE OF CHIRONOMID LARVAE ON SEDIMENT OXYGEN MICROPROFILES.
Konstanz Univ. (Germany, F.R.). Fakultaet fuer Biologie.
For primary bibliographic entry see Field 2H.
W91-04738

TOXICITY OF CADMIUM IN SEDIMENTS: THE ROLE OF ACID VOLATILE SULFIDE.
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
For primary bibliographic entry see Field 5C.
W91-04746

EFFECT OF ANTECEDENT SOIL MOISTURE ON SPLASH DETACHMENT UNDER SIMULATED RAINFALL.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.
C. C. Truman, and J. M. Bradford.
Soil Science SOSCAK, Vol. 150, No. 5, p 787-798, 1990. 5 fig, 8 tab, 21 ref.

Descriptors: *Antecedent moisture, *Rainfall impact, *Rainfall intensity, *Simulated rainfall, *Soil erosion, *Soil water, Clays, Loam, Rainfall, Shear strength, Soil management, Soil types.

Antecedent soil water content is an important variable affecting soil erosion processes and may be responsible for much of the variation in splash and wash erosion rates. The effects of antecedent water content on splash detachment and on soil splash was studied. Five soils ranging in texture from sandy loam to clay were exposed to simulated rainfall with an intensity of approximately 64 mm/h for one hour. Wash, splash, runoff, and infiltration were measured for near-saturated (-0.5 kPa) and air-dried soils in 0.14 sq. m aluminum erosion pans. Changes in the soil surface were monitored with a fall-cone device. Prewetting significantly reduced runoff occurring over a 60-minute rainfall period for the Heiden clay only. Prewetting reduced splash detachment rates for all soils except the Miami silt loam, with the greatest reduction for the Heiden clay. Total splash for the air-dried and prewetted Heiden clay was 770.1 and 169.4 g in 60 minutes, respectively. Prewetting increased soil shear strength following 60 minutes of rainfall for all soils. Development of a surface seal controlled the amount of soil detached from the Miami silt loam. Miami silt loam had the highest final shear strength values for air-dried and prewetted soils and the highest difference between initial and final shear strength among prewetted soils. Prewetted wash and splash sediment size was larger than that for air-dried sediments. Antecedent soil moisture conditions prior to rainfall influenced the amount of splash detachment and the physical processes that control amount of splash. (Author's abstract)
W91-04800

STATE-OF-THE-ART TIMBER HARVEST IN AN ARIZONA MIXED CONIFER FOREST HAS MINIMAL EFFECT ON OVERLAND FLOW AND EROSION.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 4C.
W91-04803

TRANSPORT OF SUSPENDED SEDIMENT AND DISSOLVED MATERIAL FROM THE ANDES TO THE RIO DE LA PLATA BY THE BOLIVIAN TRIBUTARIES OF THE RIO PARAGUAY (RIOS PILCOMAYO AND BERMEJO), (TRANSPORT DE MATIERES DISSOUTES ET PARTICULAIRES DES ANDES VERS LE RIO DE LA PLATA PAR LES TRIBUTAIRES BOLIVIENS (RIOS PILCOMAYO ET BERMEJO) DE RIO PARAGUAY).
Office de la Recherche Scientifique et Technique Outre-Mer, La Paz (Bolivia).
J. L. Guyot, H. Calle, J. Cortes, and M. Pereira.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 653-665, December 1990. 7 fig, 4 tab, 14 ref. English summary.

Descriptors: *Andes, *Bolivia, *Paraguay River, *Rio de la Plata, *Sediment load, *Sediment transport, *Suspended sediments, Bermejo River, Fluvial sediments, Hydrologic data collections, Pilcomayo River, River sediments, Rivers, Sediment-carrying capacity, Sedimentation.

The data collected from 13 gauging stations in the SENAMHI (Servicio Nacional de Meteorologia e Hidrologia de Bolivia) and ENDE (Empresa Nacional de Electricidad de Bolivia) networks (between 1975 and 1983), permit estimations of the suspended sediment and dissolved material yields in the Andean drainage basins of the Pilcomayo and Bermejo rivers, tributaries of the Rio Paraguay. In Bolivia, results from the Rio Pilcomayo drainage basin show that the greatest part of the transport from the basin consists of suspended sediment (90%). The sediment yield measured at the Andean exit of the Rio Pilcomayo (80,000,000 ton/year) is of the same order of size as that observed 2000 km downstream in the Middle Parana. (Author's abstract)
W91-04805

MODEL FOR COMPACTION OF SEDIMENTARY BASINS.
Institutt for Energiteknikk, Kjeller (Norway).
For primary bibliographic entry see Field 2F.
W91-04835

EROSION AND SEDIMENT CONTROL, THE MARYLAND WAY.
Maryland State Highway Administration, Baltimore.
For primary bibliographic entry see Field 4D.
W91-04852

DATA THAT DESCRIBED AT-A-POINT TEMPORAL VARIATIONS IN THE TRANSPORT RATE AND PARTICLE-SIZE DISTRIBUTION OF BEDLOAD--EAST FORK RIVER, WYOMING, AND FALL RIVER, COLORADO.
Geological Survey, Lakewood, CO. Water Resources Div.
B. Gomez, and W. W. Emmett.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-193, 1990. 48p, 3 tab, 14 ref.

Descriptors: *Bed load, *Channel morphology, *Sediment transport, Colorado, Dunes, Particle size, Wyoming.

Data from the East Fork River, Wyoming, and the Fall River, Colorado, that document at-a-point temporal variations in the transport rate and particle-size distribution of bedload, associated with the downstream migration of dunes, are presented. Bedload sampling was undertaken, using a 76.2 x 76.2 mm Helley-Smith sampler, on three separate occasions at each site in June 1988. In each instance, the sampling time was 30 seconds and the sampling intervals 5 minutes. The sampling period ranged from 4.92 to 8.25 hours. Water stage did not vary appreciably during any of the sampling periods. (USGS)
W91-04879

CHEMICAL WEATHERING IN THE LOCH VALE WATERSHED, ROCKY MOUNTAIN NATIONAL PARK, COLORADO.
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
M. A. Mast, J. I. Drever, and J. Baron.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2971-2978, December 1990. 4 fig, 4 tab, 51 ref. NSF Grant EAR-8306567.

Descriptors: *Acid rain, *Air pollution effects, *Colorado, *Geochemistry, *Mountain streams, *Solute transport, *Water chemistry, *Weathering, Acidification, Erosion, Forest hydrology, Rocky Mountain National Park, Snowmelt, Soil formation.

Mineralogic, hydrologic, and geochemical data were used to determine the source of solutes to surface waters draining the Loch Vale Watershed (LVWS), and alpine-subalpine drainage located in the Front Range of Colorado. The flux of dissolved solids from LVWS is primarily controlled by interactions between snowmelt and materials derived from the local bedrock; the biomass has only a minor effect on solute budgets except for ammonium. LVWS is underlain by Precambrian granite and gneiss, the major minerals indicate that the weathering of calcite contributes nearly 40% of the cations derived within the basin. The importance of calcite weathering in LVWS is a result of its chemical reactivity and the high rate of physical erosion in this alpine environment. The average cationitic denudation rate in the drainage (390 eq/ha/yr) is similar to long-term rates in forested Adirondack watersheds (500 to 600 eq/ha/yr), but much lower than the average for the North American Continent (3800 eq/ha/yr). Surface waters in LVWS are susceptible to acidification should acid deposition from the atmospheric increase. (Author's abstract)
W91-04926

INFLUENCE OF TEMPERATURE AND MINERAL SURFACE CHARACTERISTICS ON FELDSPAR WEATHERING RATES IN NATURAL AND ARTIFICIAL SYSTEMS: A FIRST APPROXIMATION.
Michigan State Univ., East Lansing. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W91-04932

2K. Chemical Processes

OPTICAL PROPERTIES OF SEAWATER BODIES: MEASUREMENTS WITH AN UNDERWATER RADIOMETER AND A HIGH-RESOLUTION SPECTRORADIOMETER.
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
For primary bibliographic entry see Field 7B.
W91-03950

TOTAL PARAMETER WATER ANALYSIS COMES UNDER THE MICROSCOPE.
For primary bibliographic entry see Field 5A.
W91-03970

DISSOLUTION OF FELDSPARS IN THE PRESENCE OF NATURAL, ORGANIC SOLUTES.
Sveriges Lantbruksuniversitet, Umea. Dept. of Forest Site Research.
For primary bibliographic entry see Field 2J.
W91-03986

SOIL ORGANIC MATTER, AIR ENCAPSULATION AND WATER-STABLE AGGREGATION.
Sydney Univ. (Australia). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-03988

GRANITE WEATHERING AND THE SENSITIVITY OF ALPINE LAKES TO ACID DEPOSITION.
For primary bibliographic entry see Field 2H.
W91-03998

IRON REDOX EFFECTS ON PHOTOSYNTHESIS PHOSPHORUS RELEASE FROM DISSOLVED HUMIC MATERIALS.
Kent State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W91-04000

MANGANESE SPECIATION IN DILUTE WATERS OF THE PRECAMBRIAN SHIELD, CANADA.
Ontario Ministry of the Environment, Dorchester. Dorset Research Center.
B. D. LaZerte, and K. Burling.
Water Research WATRAG, Vol. 24, No. 9, p 1097-1101, September 1990. 7 fig, 1 tab, 21 ref.

Descriptors: *Canada, *Manganese, *Organic carbon, *Voltammetry, *Water chemistry, Colloids, Hydrogen ion concentration, Lakes, Speciation, Streams.

The relative abundance of two operationally defined manganese fractions (0.4 micron filterable

Mn and DPASV labile Mn) was determined in waters (lakes, streams, and soil water seeps) draining the Precambrian shield of Canada. In contrast to its physical state in some geographical areas, manganese in waters draining the Precambrian shield is mostly non-particulate. Using a differential pulse anodic stripping voltammetry speciation technique, a trend was demonstrated from ionic Mn(II) dominance at low pH to an increasing proportion of colloidal manganese oxyhydroxides at pH > or = 5.5 in non-dystrophic waters. The relationship of Mn(II) with pH in the oxic, non-dystrophic samples is consistent with a Hausmannite or Feitknechtite controlling phase. (Author's abstract)
W91-04039

DIMETHYL SULFIDE PRODUCTION FROM DIMETHYLSULFONIOPROPIONATE IN COASTAL SEAWATER SAMPLES AND BACTERIAL CULTURES.
Georgia Univ., Sapelo Island. Marine Inst.
R. P. Kiene.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3292-3297, November 1990. 6 fig, 1 tab, 35 ref. NSF Grant OCE-8817442.

Descriptors: *Acid rain, *Coastal waters, *Environmental chemistry, *Sulfur cycle, Atmospheric chemistry, Bacteria, Bacterial growth, Dimethyl sulfide, Laboratory methods, Seawater, Water chemistry.

On a global scale, the oceans contribute about 50% of the biogenic sulfur input to the atmosphere; approximately 90% of this emission is in the form of dimethyl sulfide. Since the flux of dimethyl sulfide from the oceans is highly dependent on the concentration of dimethyl sulfide in surface seawater, it is critical that the dynamics of the dimethyl sulfide pool are understood. Dimethyl sulfide was produced immediately after the addition of 0.1 to 2 micromoles beta-dimethylsulfonio-propionate to coastal seawater samples. Azide had little effect on the initial rate of dimethyl sulfide production from 0.5 micromoles added to beta-dimethylsulfonio-propionate, but decreased the rate of production after 6 hours. Filtration of water samples through membrane filters greatly reduced dimethyl sulfide production from approximately 10 hours, after which time dimethyl sulfide production resumed at a high rate. Autoclaving completely eliminated the production of dimethyl sulfide. The antibiotics chloramphenicol, tetracycline, kanamycin, and vancomycin all had little effect on the accumulation of dimethyl sulfide over the first few hours of incubation, but produced significant inhibition thereafter. The effects of individual antibiotics were additive. Chloroform over a range of concentrations had no effects on dimethyl sulfide production. Similarly, organic amendments, including acrylate, glucose, protein, and starch, did not affect dimethyl sulfide accumulation from beta-dimethylsulfonio-propionate. Acrylate, a product of the enzymatic cleavage of beta-dimethylsulfonio-propionate, was metabolized in seawater samples, and two strains of bacteria were isolated with this compound as the growth substrate. These bacteria produced dimethyl sulfide from beta-dimethylsulfonio-propionate. The sensitivity to inhibitors, with respect to growth and enzyme activity, varied from strain to strain. (Mertz-PTT)
W91-04064

BROMATE PRODUCTION IN CHLORINATED WATERS: REACTION OF MONOCHLORAMINE AND HYPOBROMITE.
University of East Anglia, Norwich (England). School of Environmental Sciences.
A. Bousher, P. Brimblecombe, and D. Midgley.
Water Research WATRAG, Vol. 24, No. 10, p 1285-1294, October 1990. 9 fig, 3 tab, 24 ref.

Descriptors: *Bromine compounds, *Chemical analysis, *Chlorination, *Pollutant identification, *Residual chlorine, *Water pollution sources, Bromates, Chemical reactions, Chlorine, Disinfection, Fouling, Water treatment.

Chlorine is added to the cooling water of power stations and other large industrial plant waters in order to prevent biological fouling of the condensers. Residual chlorine is known to consist of a variety of chemical species. This is particularly so in sea water, where the presence of bromide results in most of the residual chlorine being present as bromine-containing species. Voltammetric studies were carried out with a Princeton Applied Research polarograph. A 0.0012 mole/decameter monochlorine solution was mixed with an equal volume of sodium hypobromite solution and allowed to react for 30 minutes at room temperature before the absorbance spectrum was recorded. Mixed solutions produced bromate, rather than the NHBrCl that might have been expected. Bromate was identified by ultra violet spectrophotometry and polarography. The stoichiometric ratio for the reaction showed that, in excess monochloramine, 1 mole of hypobromite reacted with 2 moles of monochloramine, while in excess hypobromite, 2 moles of hypobromite reacted with 1 mole of monochloramine. The rate of loss of hypobromite was followed voltammetrically at a rotating platinum electrode and was found to be first-order with respect to hypobromite and hydroxide ion concentrations. It was established that ion-pair formation between hypobromite and sodium retards the reaction. Retardation by bromide (but not by other anions) indicates that bromite as an intermediate step in its formation appears to be rate-determining. (Mertz-PTT)
W91-04085

PREDICTION OF THE TEMPERATURE DEPENDENCE OF ELECTRICAL CONDUCTANCE FOR RIVER WATERS.
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 7B.
W91-04086

SHORTCOMINGS OF GRAN TITRATION PROCEDURES FOR DETERMINATION OF ALKALINITY AND WEAK ACIDS IN HUMIC WATER.
National Inst. of Public Health, Oslo (Norway).
For primary bibliographic entry see Field 7B.
W91-04087

SULFUR ISOTOPE EVIDENCE FOR REGIONAL RECHARGE OF SALINE WATER DURING CONTINENTAL GLACIATION, NORTH-CENTRAL UNITED STATES.
Syracuse Univ., NY. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-04107

HYDROGEOLOGY OF AN ANCIENT ARID CLOSED BASIN: IMPLICATIONS FOR TABULAR SANDSTONE-HOSTED URANIUM DEPOSITS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W91-04108

OXIDATION AND REDUCTION OF RADIOLABELED INORGANIC SULFUR COMPOUNDS IN AN ESTUARINE SEDIMENT, KYSING FJORD, DENMARK.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
H. Fossing, and B. B. Jorgensen.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 10, p 2731-2742, October 1990. 13 fig, 41 ref. Danish Ministry of the Environment and the Danish Natural Science Research Council Grants No. 115735, 116308, and 116711.

Descriptors: *Estuarine sediments, *Radioactive tracers, *Sulfur compounds, *Sulfur cycle, Denmark, Kysing Fjord, Oxidation, Reduction, Sediment analysis, Soil cores.

S-35-labeled sulfate, thiosulfate, elemental sulfur, total divalent sulfur (=H2S+HS(-)+S(-2) and pyrite were used to trace the oxidative and reductive pathways of the sulfur cycle. The transformation of inorganic sulfur compounds was studied in 8-cm long undisturbed estuarine sediment cores in time course experiments of up to 24 h. All of the tracers, except for pyrite, were oxidized and/or reduced at all depths. More than 65% of the S35 from (S35)sulfate reduction was recovered as elemental sulfur in the top two cm of the sediment. At depths greater than 2 cm, nearly all of the reduced (S35)sulfate was recovered as hydrogen sulfide plus pyrite. Thiosulfate was not detected in the sediment. From the combined data of outer-labelled and inner-labelled (S35)thiosulfate injections, concurrent oxidation, reduction, and disproportionation of thiosulfate tracer were demonstrated. In oxidized surface sediment the three processes comprised 10, 24, and 66%, respectively, of the metabolized (S35)thiosulfate. In reduced sediment these percentages were 16, 45, and 39%. Injections of (S35)sulfide into thiosulfate-spiked sediment cores produced 71% (S35)sulfate and 29% (S35)thiosulfate (% of the total labeled sulfate and thiosulfate) in the oxidized zone and 8% (S35)sulfate and 92% (S35)thiosulfate in the reduced zone. A similar experiment with S35-labeled elemental sulfur resulted in 62% of the label in sulfate and 38% in thiosulfate in the oxidized zone and 22% in sulfate, 78% in thiosulfate in the reduced zone. More than half of the labeled elemental sulfur and sulfide oxidation to sulfate was calculated to have proceeded through thiosulfate in the reduced sediment. In oxidized sediment these percentages were 15% for sulfide and 21% for elemental sulfur. Thiosulfate was thus a key intermediate in the sulfur cycle. (Author's abstract)
W91-04155

CHARACTERISTICS OF SURFACTANTS IN TOXICITY IDENTIFICATION EVALUATIONS.
Environmental Research Lab., Duluth, MN.
For primary bibliographic entry see Field 5A.
W91-04246

TRACE METAL IONS IN GANGA WATER SYSTEM.
Industrial Toxicology Research Centre, Lucknow (India).
D. P. Modak, K. P. Singh, S. Ahmed, and P. K. Ray.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 275-287, 1990. 3 fig, 4 tab, 10 ref.

Descriptors: *Ganges River, *Geochemistry, *India, *Rivers, *Sediment transport, *Trace metals, *Water chemistry, Alkalinity, Arsenic, Bay of Bengal, Cadmium, Carbonates, Chemical composition, Chromium, Copper, Data acquisition, Data collections, Databases, Emission spectroscopy, Gypsum, Iron, Lead, Manganese, Nickel, Pyrite, Seasonal variation, Streamflow, Sulfates, Water analysis, Water quality, Zinc.

Trace elements in ocean water result from rivers, the atmosphere, and volcanic activities. Globally, in terms of sediment transport, the river Ganges appears to occupy first place. However, in terms of the flow of the river water, the Ganges occupies fourth place. The Ganges and its tributaries are typical carbonate rivers with alkalinity accounting for over half the anion balance. The major inorganic anion, after CO3(2-) is SO4(2-), reflecting the dissolution of carbonate bearing rocks, pyrites, and gypsum in the upper reaches of the river. The trace metal composition of the river Ganges and influx of metals to the Bay of Bengal were sampled at monitoring stations selected with a view to generating a data base on the quality of the Indian river systems. All samples were collected as composite samples each month for a period of two years. Data obtained in the study show that the river Ganges transports 0.00005 million tons (MT) of As and Cd, 0.015 MT of Cr, 0.007 MT of Cu, 4.1 MT of Fe, 0.014 MT of PB, 0.056 MT of Mn, 0.005 MT of Ni, and 0.14 MT of Zn each year. The quantity of trace metals are dictated by the weathering of rocks and minerals, soil erosion, industrial activities and influxes from various tributaries. The concentrations of most of the metals were found to be highest during peak flow conditions, with concentrations dropping during moderate flow and lean flow. Trace metal composition of the river Ganges was found to be similar to that of the

Rhine river, but less than those of the Amazon and Mississippi rivers. (Korn-PTT)
W91-04259

PH OF CLAY SUSPENSIONS IN THE FIELD AND LABORATORY, AND METHODS OF MEASUREMENT OF THEIR PH.
Missouri Univ., Columbia. Dept. of Geology.
W. D. Keller, and K. Matlack.
Applied Clay Science ACLSER, Vol. 5, No. 2, p 123-133, August 1990. 2 tab, 13 ref. NSF Grant EAR 8119592 and G9159.

Descriptors: *Analytical methods, *Chemical properties, *Clay minerals, *Clays, *Hydrogen ion concentration, *Water chemistry, Chemical analysis, Chemical interactions, Colorimetry, Data acquisition, Geochemistry, Ion-selective electrodes, Water analysis.

The pH of aqueous effluent from rocks, and water (including glacial milk) flowing across various kinds of rocks, is influenced by the composition of the rocks. The pH of water standing in pools in deposits of kaolin-family clays tends to be low, i.e., pH 4 to 5. Streams draining such clay-containing areas commonly also yield pH values below 7, whereas streams flowing over primary, and clay-parent, silicate rocks typically yield a pH of 7 or higher. Therefore, testing the pH of streams may aid in clay-prospecting in igneous country-rock areas. Laboratory-prepared suspensions of clays, similar to natural clay sols, are acid within the kaolin family but may be alkaline with Na-smectite. Measurements of pH made on the visually clear supernatants of clay sols using colorimetric test paper and glass electrode methods indicate that the colorimetric method yields the most representative results. Apparently, the multitude of clay-surface properties and charge effects from clay in even the visually clear sol override and mask the specific electrical properties by which an electrometric methods measures the pH value of a clean ionic-molecular solution. (Author's abstract)
W91-04269

HYDROTHERMAL PETROLEUMS FROM YELLOWSTONE NATIONAL PARK, WYOMING, USA.
Oregon State Univ., Corvallis. Coll. of Oceanography.
For primary bibliographic entry see Field 2F.
W91-04270

PORE-WATER GEOCHEMISTRY AND THE MINERALOGY OF THE VADOSE ZONE OF SULFIDE TAILINGS, WAITE AMULET, QUEBEC, CANADA.
Waterloo Centre for Groundwater Research (Ontario).
For primary bibliographic entry see Field 5B.
W91-04271

NUMERICAL METHOD FOR PARAMETERIZATION OF ATMOSPHERIC CHEMISTRY: COMPUTATION OF TROPOSPHERIC OH.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
C. M. Spivakovsky, S. C. Wofsy, and M. J. Prather.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 11, p 18,433-18,439, October 20, 1990. 3 fig, 2 tab, 6 ref. NASA Grant NAG5-719, NSF Grant ATM84-13153.

Descriptors: *Atmospheric chemistry, *Computer models, *Mathematical models, *Numerical analysis, *Path of pollutants, Albedo, Environmental tracers, Hydroxyl radicals, Parameterization, Statistical analysis, Three-dimensional model.

An efficient and stable computational scheme for parameterization of atmospheric chemistry is described. The 24-h average concentration of OH is represented as a set of high-order polynomials in variables such as temperature, densities of water, carbon monoxide, ozone and nitrogen oxides as well as variables determining solar irradiance: cloud cover, density of the overhead ozone column, surface albedo, latitude, and solar declination. This parameterization of OH chemistry was used in the three-dimensional study of global distribution of trichloroethane. The proposed computational scheme can be used for parameterization of rates of chemical production and loss or of any other output of a full chemical model. Coefficients for the polynomials are computed to provide the least squares fit to results of the full chemical model. Highly overdetermined systems are used with the sets of independent variables selected randomly in accordance with the distributions expected in the atmosphere. The least squares problem is solved using the Householder method of triangulation (by orthogonal transformations). The method allows detection and rectification of ill-defined conditions (i.e., linear dependence among terms), as well as evaluation of the individual contribution of each term of the polynomial in reducing the residual vector. On the basis of that information the terms that have little bearing on the residual norm are discarded. Once the domain and the statistical distributions of independent variables are chosen, the entire parameterization process is implemented as a complete sequence of computer programs requiring no subjective analysis. The output of the procedure includes estimates of accuracy of the approximation against an independent sample of points, and computer written FORTRAN subroutines to compute the polynomials. (See also W91-04300) (Author's abstract)
W91-04299

TROPOSPHERIC OH IN A THREE-DIMENSIONAL CHEMICAL TRACER MODEL: AN ASSESSMENT BASED ON OBSERVATIONS OF CH3CCL3.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
For primary bibliographic entry see Field 5B.
W91-04300

SMOG-FOG-SMOG CYCLE AND ACID DEPOSITION.
California Inst. of Tech., Pasadena. Dept. of Chemical Engineering.
S. N. Pandis, J. H. Seinfeld, and C. Pilinis.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 11, p 18,489-18,500, October 20, 1990. 9 fig, 1 tab, 28 ref. State of California Air Resources Board Agreement A932-079.

Descriptors: *Acid rain, *Aerosols, *Air pollution, *Atmospheric chemistry, *Fog, *Model studies, *Path of pollutants, Fluid drops, Particle size, Sulfates, Urban areas.

A model including descriptions of aerosol and droplet microphysics, gas and aqueous-phase chemistry, and deposition is used to study the transformation of aerosol to fog droplets and back to aerosol in an urban environment. Fogs in polluted environments have the potential to increase aerosol sulfate concentrations but at the same time to cause reductions in the aerosol concentration of nitrate, chloride, ammonium and sodium as well as in the total aerosol mass concentration. The sulfate produced during fog episodes favors the aerosol particles that have access to most of the fog liquid water which are usually the large particles. Aerosol scavenging efficiencies of around 80% were calculated for urban fogs. Sampling and subsequent mixing of fog droplets of different sizes may result in measured concentrations that are not fully representative of the fogwater chemical composition and can introduce errors in the reported values of the ionic species deposition velocities. Differences in the major ionic species deposition velocities can be explained by their distribution over the droplet size spectrum and can be corrected with the species average diameter. Two different expressions were derived for use in fog models for the calculation of liquid water deposition velocity during fog growth and dissipation stages. (Author's abstract)
W91-04301

ONE-DIMENSIONAL NUMERICAL MODEL TO SIMULATE FORMATION AND BALANCE OF SULFATE DURING RADIATION FOG EVENTS.
Munich Univ. (Germany, F.R.). Meteorologisches Inst.
R. Forkel, W. Seidl, R. Dlugi, and E. Deigele.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 11, p 18,501-18,515, October 20, 1990. 9 fig, 6 tab, 63 ref, append. BMFT (Ministry for Research and Technology of the FRG) Project 07442033.

Descriptors: *Acid rain, *Atmospheric chemistry, *Fog, *Mathematical models, *Sulfates, Acidic water, Acidification, Aerosols, Atmospheric water, Simulation analysis, Soil properties, Water chemistry.

A one-dimensional numerical model of the atmospheric boundary layer is coupled with a bulk phase aqueous chemistry model to simulate meteorological conditions, sulfate production, and pH values during radiation fog events. The boundary layer model includes prognostic equations for atmospheric temperature, specific humidity, liquid water content, wind speed, and the concentrations of the gas phase and liquid phase chemical reactants. Within the soil, temperature and liquid water content are predicted. A hybrid equilibrium and kinetic aqueous chemistry model is used to predict reactant concentrations in the fog water. The model is used to investigate the influence of soluble aerosol material and of trace gases on sulfur dioxide oxidation, on fog water pH, and on deposition fluxes due to sedimentation. As the meteorological conditions have an influence on fog height, liquid water content, and duration, not only the initial aerosol composition and the trace gas concentrations but also the thermodynamic an dynamic conditions of the atmosphere and soil properties have an impact on liquid phase sulfate production during the fog event. With the exception of the dissipation stage, the turbulent transport of oxidants from aloft into the fog layer has only a small influence on the production of sulfate within a fog layer. An important mechanism for downward supply of fresh material is the rise of the fog top, followed by sedimentation of droplets. Sedimentation also results in the removal of a considerable amount of aerosol material from the fog layer. (Author's abstract)
W91-04302

POTENTIAL EFFECTS OF RAISING PH FOR CORROSION CONTROL ON THE AESTHETIC QUALITIES OF A WATER SUPPLY.
Whitman and Howard, Inc., Wellesley, MA.
For primary bibliographic entry see Field 5F.
W91-04370

EFFECT OF OZONATION ON THE REMOVAL OF ORGANICS BY COAGULATION/FLOCCULATION.
Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.
For primary bibliographic entry see Field 5F.
W91-04383

STATISTICAL ANALYSIS OF THE HYDROCHEMISTRY OF GROUND WATERS IN COLUMBIA RIVER BASALTS.
Idaho Univ., Moscow. Coll. of Mines and Earth Resources.
For primary bibliographic entry see Field 2F.
W91-04401

RELATIONSHIPS BETWEEN GROUNDWATER CONTAMINATION AND MAJOR-ION CHEMISTRY IN A KARST AQUIFER.
Kentucky Univ., Lexington.
For primary bibliographic entry see Field 5B.
W91-04403

RESPONSE OF YELLOW-POPLAR (LIRIODENDRON TULIPIFERA L.) SEEDLINGS TO SIMULATED ACID RAIN AND OZONE--2. EFFECT ON THROUGHFALL CHEMISTRY AND NUTRIENTS IN THE LEAVES.
Northeastern Forest Experiment Station, Delaware, OH.

For primary bibliographic entry see Field 2I.
W91-04451

GEOTHERMAL RESOURCES OF THE WESTERN ARM OF THE BLACK ROCK DESERT, NORTHWESTERN NEVADA: PART II, AQUEOUS GEOCHEMISTRY AND HYDROLOGY.
Geological Survey, Carson City, NV. Water Resources Div.
A. H. Welch, and A. M. Preissler.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4062, 1990. 91p, 22 fig, 8 tab, 80 ref.

Descriptors: *Geochemistry, *Geothermal resources, *Geothermal studies, *Isotope studies, *Nevada, Black Rock Desert, Evaporation, Geothermal water, Hydrology, Salinity, Thermal water, Thermodynamics, Water chemistry.

The western arm of the Black Rock Desert, Nevada, includes several distinct hydrothermal systems, some of which exceed 150 C and may exceed 200 C at depth, determined on the basis of chemical geothermometry. The cation composition of the thermal water appears to be controlled by aluminosilicate minerals that are common in other active geothermal systems. Estimates of the equilibrium temperatures at which some mineral pairs are stable, when compared with the more commonly applied geothermometer estimates, indicate that thermodynamic data may be useful for estimating deep aquifer temperatures. Thermal water at Great Boiling and Mud Springs, which has a chloride concentration of about 2,000 mg/L and a total dissolved-solids concentration of 4,500 mg/L, appears to have been affected by shallow evapotranspiration in an adjacent playa prior to deep circulation. This model of recharge within the basin floor is distinctly different from models proposed for most other geothermal systems in the northern Great Basin. (USGS)
W91-04462

HYDROGEOCHEMICAL DATA FROM AN ACIDIC DEPOSITION STUDY AT MCDONALDS BRANCH BASIN IN THE NEW JERSEY PINELANDS, 1983-86.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04472

GROUND-WATER-QUALITY ASSESSMENT OF THE CARSON RIVER BASIN, NEVADA AND CALIFORNIA: ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
Geological Survey, Carson City, NV. Water Resources Div.
A. H. Welch, R. W. Plume, E. A. Frick, and J. L. Hughes.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-382, 1989. 115p, 35 fig, 17 tab, 1 pl, 86 ref.

Descriptors: *Arsenic, *Carson River Basin, *Groundwater pollution, *Groundwater quality, *Iron, *Manganese, *Nevada, *Water pollution sources, *Water quality, Alluvial aquifers, Arid zone, Dissolved solids, Fluorides, Groundwater, Hydrogeology, Water supply, Water use, Well water.

Data on groundwater quality, hydrogeology, and land and water use for the Carson River basin, Nevada and California were analyzed as part of the U.S. Geological Survey National Water-Quality Assessment program. The basin consists of six hydrographic areas--a mountainous headwaters area and five downstream areas interconnected by the Carson River. Each valley contains one or more basin-fill aquifers. The data on groundwater quality came from several agencies and were screened to verify site location and to avoid analyses of treated water. The screened data are stored in the U.S. Geological Survey National Water Information System data base. Differences in sample-collection and preservation procedures among some of the data-collection agencies restrict use of the data to a descriptive analysis. Drinking water standards were employed as the basis for evaluating reported concentrations. Frequencies with which primary or secondary standards are exceeded increase from upstream parts of the basin to downstream parts. Primary standards commonly exceeded are fluoride in upstream areas and arsenic and fluoride in downstream areas. Secondary standards commonly exceeded are iron and manganese in upstream areas and chloride, dissolved solids, iron, manganese, and sulfate in downstream areas. The poorer-quality groundwater generally is a result of natural geochemical reactions, rather than the introduction of chemicals by man. Limited data indicate, however, that manmade organic compounds are present, mostly at or near urban land. (USGS)
W91-04476

DISSOLVED ARSENIC IN THE ST. LAWRENCE ESTUARY AND THE SAGUENAY FJORD, CANADA.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
For primary bibliographic entry see Field 5B.
W91-04519

USE OF FLUORESCENCE SPECTROSCOPY TO STUDY HERBICIDE-HUMIC ACID INTERACTIONS: PRELIMINARY OBSERVATIONS.
Agriculture Canada, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 5B.
W91-04587

GEOHYDROLOGY AND WATER QUALITY OF CONFINED-DRIFT AQUIFERS IN THE BROOTEN-BELGRADE AREA, WEST-CENTRAL MINNESOTA.
Geological Survey, St. Paul, MN.
For primary bibliographic entry see Field 2F.
W91-04635

MICROBIAL MANGANESE REDUCTION MEDIATED BY BACTERIAL STRAINS ISOLATED FROM AQUIFER SEDIMENTS.
Lyon-1 Univ., Villeurbanne (France). Lab. de Microbiologie-Physiologique et Appliqueee.
J. Di-Ruggiero, and A. M. Gounot.
Microbial Ecology MCBEBU, Vol. 20, No. 1, p 53-63, July/August 1990. 3 fig, 4 tab, 32 ref.

Descriptors: *Aquatic bacteria, *Aquifers, *Bacteria, *Geochemistry, *Manganese, *Microbial degradation, *Sediments, *Water chemistry, Acinetobacter, Bacillus, Conductivity, Corynebacterium, Culturing techniques, Escherichia coli, Hydrogen ion concentration, Laboratory methods, Pseudomonas.

One hundred and five bacterial strains isolated from aquifer sediments from the Rhone valley, France and Escherichia coli ML30S were tested for their ability to reduce manganese oxides. Eighty-two strains, including E. coli, reduced manganese. In most cases the bacterial activity decreased the pH and Eh below 6.75 and 350 mV, respectively, enhancing a spontaneous and nonspecific reduction of manganese. For 12 strains the reduction was specifically catalyzed by bacteria; the high pH and Eh values would not permit a spontaneous reduction of manganese. Some of the most active strains were identified as genera common in soils and waters, i.e., Pseudomonas, Bacillus, Corynebacterium, and Acinetobacter. Two strains were studied in detail. One of the strains, identified as Pseudomonas fluorescens, required contact between the cells and the manganese oxides for reduction to occur. The reduction was inhibited by 15 mM of sodium azide. The other strain, identified as Acinetobacter johnsonii, catalyzed manganese reduction by an inductive and dialyzable substance which was excreted by the bacteria. The mechanism involved has not been previously demonstrated. (Author's abstract)
W91-04726

REACTIONS BETWEEN ALUMINUM AND SULFATE IN DILUTE NUTRIENT SOLUTIONS WITH VARYING DEGREES OF HYDROLYSIS.
Florida Univ., Lake Alfred. Citrus Experiment Station.
A. K. Alva, G. L. Kerven, D. G. Edwards, and C. J. Asher.
Soil Science SOSCAK, Vol. 150, No. 2, p 495-505, 1990. 5 fig, 3 tab, 32 ref.

Descriptors: *Aluminum, *Hydrolysis, *Nutrient concentrations, *Soil chemistry, *Soil water, *Sulfates, Molar ratio, Precipitates, Soil solution, Soil-water-plant relationships, Speciation, Supersaturation.

A clear understanding of the forms of aluminum present in solutions is necessary to diagnose Al toxicity properly in plant root environments. In soil solutions, interaction of Al with organic ligands plays an important role in determining the concentration of biologically-active Al. Effects of hydrolysis of aluminum (300 microM) at hydroxide/aluminum molar ratios of 0, 1, or 2 on forms of aluminum were studied in de-ionized water and in a dilute nutrient solution matrix during 20 days of aging. In the dilute nutrient solution series, varying sulfate additions were made to obtain a sulfate/aluminum molar ratio of 5 or 20. Aluminum was supplied as Aluminum potassium sulfate or aluminum nitrate and additional sulfate was supplied as calcium sulfate. The solution pH varied from 4.2 to 4.7 with increase in degree of hydrolysis. The trends in pH with time were generally similar in the absence or presence of basal nutrients. In the absence of basal nutrients, increase in hydroxide/aluminum molar ratio decreased the concentration of total aluminum in solution with aluminum potassium sulfate but not with aluminum nitrate. However, in the presence of basal nutrients, concentrations of total and monomeric aluminum only in hydrolyzed aluminum solutions. Precipitates found in hydrolyzed aluminum solutions were amorphous and contained aluminum and sulfur, with the sulfur/aluminum ratio ranging from 0.15 to 0.27, depending on the source of aluminum, the degree of hydrolysis, the presence of basal nutrients, and the sulfate/aluminum molar ratio. Speciation calculations using the MINTEQ program showed supersaturation with respect to aluminum hydroxysulfate and alunite in solutions containing a sulfate/aluminum molar ratio of 5 or 20 using either aluminum potassium sulfate or aluminum nitrate, and in solutions containing aluminum potassium sulfate with no addition of sulfate. (Author's abstract)
W91-04910

DEGRADATION OF ATRAZINE IN SOIL THROUGH INDUCED PHOTOCATALYTIC PROCESSES.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
For primary bibliographic entry see Field 5B.
W91-04911

ISOTOPIC EVOLUTION OF RIVER WATER IN THE NORTHERN CHILE REGION.
Waterloo Centre for Groundwater Research (Ontario).
R. Aravena, and O. Suzuki.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2887-2895, December 1990. 5 fig, 3 tab, 45 ref.

Descriptors: *Carbon isotopes, *Chile, *Geohydrology, *Groundwater resources, *Hydrogen isotopes, *Isotope studies, *Oxygen isotopes, *Rivers, *Water resources, Atmosphere, Carbon cycle, Carbon dioxide, Geothermal water, Groundwater recharge, Organic carbon, Paleohydrology, Tributaries, Water chemistry.

Two main northern Chilean rivers, the Loa and Tarapaca, were investigated regarding their isotopic characteristics. Groundwater associated with various recharge zones, and the input of tributaries along their courses, mainly control their (oxygen-18, hydrogen) isotopic composition of the rivers. In the Loa river, carbon isotopic exchange be-

tween dissolved inorganic carbon (DIC) and atmospheric carbon dioxide plays a minor role in the inorganic carbon cycle of the Loa river. The carbon isotopic composition (carbon-14, carbon-13) of this river is probably controlled by carbon sources associated with volcanic and geothermal activities and by the deposition of travertines. For the Tarapaca river the carbon isotope content of the DIC reflects the input of recirculated water from irrigated areas along the river and carbon isotopic exchange. These results imply that the input of volcanic and/or geothermal carbon dioxide into the DIC pool has to be evaluated in order to use carbon isotopes as a dating tool for groundwater in the Loa basin and that modern conditions are not analogous to the paleohydrology of the Tarapaca river. (Author's abstract)
W91-04917

DISSOLVED ORGANIC CARBON CYCLING IN FORESTED WATERSHEDS: A CARBON ISOTOPE APPROACH.
Waterloo Centre for Groundwater Research (Ontario).
S. L. Schiff, R. Aravena, S. E. Trumbore, and P. J. Dillon.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2949-2957, December 1990. 4 fig, 2 tab, 42 ref.

Descriptors: *Acid rain effects, *Carbon cycle, *Carbon isotopes, *Dissolved organic carbon, *Forest watersheds, *Isotope studies, *Water chemistry, Acid rain, Aquifers, Ontario, Path of pollutants, Soil chemistry, Trace metals.

Dissolved organic carbon (DOC) is important in the acid-base chemistry of acid-sensitive freshwater systems; in the complexation, mobility, persistence, and toxicity of metals and other pollutants; and in lake carbon metabolism. Carbon isotopes (carbon-13 and carbon-14) are used to study the origin, transport and fate of DOC in a softwater catchment in central Ontario. Precipitation, soil percolates, groundwaters, stream, beaver pond, and lake waters, and lake sediment pore water were characterized chemically and isotopically. In addition to total DOC, isotopic measurements were made on the humic and fulvic DOC fractions. The lake is a net sink for DOC. Delta carbon-14 results indicate that the turnover time of most of the DOC in streams, lakes, and wetlands is fast, less than 40 years, and on the same time scale as changes in acidic deposition. DOC in groundwaters is composed of older carbon than surface waters, indicating extensive cycling of DOC in the upper soil zone or aquifer. (Author's abstract)
W91-04924

CHEMICAL WEATHERING IN THE LOCH VALE WATERSHED, ROCKY MOUNTAIN NATIONAL PARK, COLORADO.
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2J.
W91-04926

GROUNDWATER AND WETLAND CONTRIBUTIONS TO STREAM ACIDIFICATION: AN ISOTOPIC ANALYSIS.
Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
For primary bibliographic entry see Field 5B.
W91-04928

MECHANISMS AFFECTING STREAMFLOW AND STREAM WATER QUALITY: AN APPROACH VIA STABLE ISOTOPE, HYDROGEOCHEMICAL, AND TIME SERIES ANALYSIS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W91-04929

HYDROGEOCHEMICAL RESPONSE OF A FORESTED WATERSHED TO STORMS: EFFECTS OF PREFERENTIAL FLOW ALONG SHALLOW AND DEEP PATHWAYS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2E.
W91-04930

INFLUENCE OF TEMPERATURE AND MINERAL SURFACE CHARACTERISTICS ON FELDSPAR WEATHERING RATES IN NATURAL AND ARTIFICIAL SYSTEMS: A FIRST APPROXIMATION.
Michigan State Univ., East Lansing. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W91-04932

LINKING HYDROLOGICAL, GEOCHEMICAL, AND SOIL CHEMICAL PROCESSES ON THE CATCHMENT SCALE: AN INTERPLAY BETWEEN MODELING AND FIELD WORK.
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 2A.
W91-04935

CHEMISTRY OF IRON, ALUMINIUM, AND DISSOLVED ORGANIC MATERIAL IN THREE ACIDIC, METAL-ENRICHED, MOUNTAIN STREAMS, AS CONTROLLED BY WATERSHED AND IN-STREAM PROCESSES.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2E.
W91-04936

2L. Estuaries

OPTICAL PROPERTIES OF SEAWATER BODIES: MEASUREMENTS WITH AN UNDERWATER RADIOMETER AND A HIGH-RESOLUTION SPECTRORADIOMETER.
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
For primary bibliographic entry see Field 7B.
W91-03950

MONITORING OFFSHORE WATER QUALITY FROM SPACE.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 7B.
W91-03953

PRELIMINARY STUDY ON NEARSHORE WATER IN CHINA WITH NOAA SATELLITE IMAGES.
National Bureau of Oceanography, Hangzhou (China). Second Inst. of Oceanography.
For primary bibliographic entry see Field 7B.
W91-03955

WETLAND SOIL FORMATION IN THE RAPIDLY SUBSIDING MISSISSIPPI RIVER DELTAIC PLAIN: MINERAL AND ORGANIC MATTER RELATIONSHIPS.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
J. A. Nyman, R. D. Delaune, and W. H. Patrick.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 1, p 57-69, July 1990. 5 fig, 1 tab, 34 ref. USGS Grant No. 14-08-0001-23411.

Descriptors: *Minerals, *Mississippi River Delta, *Organic matter, *Soil genesis, *Wetlands, Coastal marshes, Rainfall, Saline-freshwater interfaces, Salinity, Sediments, Soil profiles, Spartina, Submergence.

The elevation of submerging coastal marshes is maintained by vertical accretion of mineral and organic matter. Submergence rates currently exceed 0.1 cm/yr in the Mississippi Deltaic Plain and are expected to increase. Mineral matter-organic matter relationships were examined in surface profiles of Mississippi Deltaic Plain soil from both Active Delta Zone marsh (which receives freshwater and mineral sediment from the Atchafalaya or Mississippi Rivers) and Inactive Delta Zone marsh (which relies on rainfall for freshwater and on reworked sediments for mineral matter) to gain insights into marsh soil structure and formation. Mineral and organic matter accounted for 4 to 14% of soil volume. The remainder was pore space and was occupied by water and entrapped gases. Organic matter occupied more volume than mineral matter in all but saline marsh soil. The regular influx of mineral matter to active fresh marsh resulted in active fresh marsh soil containing twice as much mineral and organic matter as inactive fresh marsh soil. Within the Inactive Delta Zone, the volume of mineral and organic matter increased from fresh (inland) to saline (seaward) marshes. Saline marsh soil required 1.7 times as much mineral matter as brackish marsh soil to vertically accrete at similar rates, possibly as a result of soil bulk density requirements of the dominant saline marsh plant, Spartina alterniflora. Vertical accretion rates were highest in the Active Delta Zone, probably as a result of increased mineral matter availability and delivery. Current, best estimates of the combination of mineral and organic matter required (g/sq m/yr) to maintain marsh surface-water level relationship are fresh marsh: organic matter = 1700 + 269x, mineral matter = 424x; brackish marsh: organic matter = 553 + 583x, mineral matter = 1052x; saline marsh: organic matter = 923 + 601x, mineral matter = 1798x, where x = the rate of submergence (cm/yr). (Author's abstract)
W91-03978

ASSESSMENT OF METAL CONTAMINATION OF SEDIMENTS IN THE HUMBER ESTUARY, U.K.
Hull Univ. (England). Dept. of Applied Biology.
For primary bibliographic entry see Field 5B.
W91-03979

PATHWAYS OF SILVER UPTAKE AND ACCUMULATION BY THE AMERICAN OYSTER (CRASSOSTREA VIRGINICA) IN THE CHESAPEAKE BAY.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.
W91-03980

CAUSES OF LIGHT ATTENUATION IN NINE NEW ZEALAND ESTUARIES.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
W. N. Vant.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 125-137, August 1990. 7 fig, 4 tab, 36 ref.

Descriptors: *Estuaries, *Estuarine environment, *Light penetration, *New Zealand, *Turbidity, Biomass, Chlorophyll, Climates, Floodwater, Mathematical models, Mixing, Phytoplankton, Plant growth, Seasonal variation, Suspended sediments, Tidal effects.

The optical properties of a water body determine the underwater light climate for plant growth, as well as important aspects of its appearance. Optical properties and the constituent composition of the waters of nine northern New Zealand estuaries were determined during 1988-1989. Substantial variation was found both within and between the estuaries. For characteristics such as beam attenuation, turbidity and suspended solids, sources of variation in particular estuaries included: state of the tide (causing three-fold differences); seasonal changes (five-fold to ten-fold); incomplete mixing; both horizontal (two-fold to three-fold) and, in one case, vertical (about two-fold); and the presence of floodwaters (at least five-fold). The waters at the estuary mouths were fairly turbid (Secchi depths 1.2 to 4.4 m), and were comparatively bright (PAR reflectance 6 to 12%), because the constituents tended to scatter more light than they absorbed (7 to 17 times more on average). Phytoplankton biomass was low (chlorophyll a, 0.5 to 5 mg/cu m) and suspended particulates were mostly inorganic

(82%). Equations were derived which describe how the water constituents affect the estuaries' optical properties. Reasonably reliable predictions resulted when the equations were tested against a separate data set. The inorganic suspensoids (3 to 11 g/cu m) caused 56% of beam attenuation, four times that caused by phytoplankton. Scattering per unit mass of suspensoids was several times lower than that found in some New Zealand lakes because of the larger average particle size of the estuarine material. Oxidation pond effluent discharged to one of the estuaries had little effect on beam attenuation there. (Author's abstract)
W91-03981

SEASONAL ABUNDANCES OF PLANKTONIC CILIATES AND MICROFLAGELLATES IN MESOHALINE CHESAPEAKE BAY WATERS.
Johns Hopkins Univ., Shady Side, MD. Chesapeake Bay Inst.
J. R. Dolan, and D. W. Coats.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 157-175, August 1990. 8 fig, 3 tab, 77 ref. NSF Grant OCE88-00076.

Descriptors: *Chesapeake Bay, *Ciliates, *Estuarine environment, *Flagellates, *Population density, *Seasonal variation, Bacterial physiology, Brackish water, Chlorophyll, Eutrophication, Phytoplankton, Temporal distribution.

Ciliate, heterotrophic microflagellate (hflag) and autotrophic microflagellate (aflag) abundances are reported for mesohaline Chesapeake Bay waters based on samples gathered from April through October 1985 to 1987. Total water column averages for ciliate and microflagellate abundances were typical of eutrophic marine systems. Ciliate density ranged from 17.2 cells/ml in April to 1.8 cells/ml in September; hflag ranged from 3700 cells/ml in June to 1100 cells/ml in October. In spring, the majority of ciliate and hflag standing stocks (70% and 64%, respectively) were located in bottom and transition waters; during summer months the majority (approximately 85% of both groups) were in surface and transition waters. During fall, ciliate stock was concentrated (72%) in surface waters and hflag were relatively evenly distributed in the three water column zones. Ciliate and microflagellate numbers were not directly related to chlorophyll a concentrations except in the bottom layer, where simultaneous declines accompanied anoxia. Ciliate concentrations correlated with total numbers of microflagellates and hflag abundance, but not aflag density. The abundance trends of ciliates in the Chesapeake Bay could be a function of food availability, but there are no data available on seasonal shifts in bacterial production with which to evaluate this hypothesis. Preliminary reports giving estimates of in situ ciliate grazing rates on phytoplankton and bacterioplankton in Chesapeake waters have emphasized findings of temporal and spatial variability, but further work to clarify the magnitude and regulating factors is needed. (Author's abstract)
W91-03982

SUCCESSIVE APPEARANCE OF SUBFOSSIL PHYTOPLANKTON SPECIES IN HOLOCENE SEDIMENTS OF THE NORTHERN ADRIATIC AND ITS RELATION TO THE INCREASED EUTROPHICATION PRESSURE.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
S. Puskaric, G. W. Berger, and F. J. Jorissen.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 177-187, August 1990. 6 fig, 31 ref.

Descriptors: *Adriatic Sea, *Eutrophication, *Marine sediments, *Phytoplankton, *Water pollution effects, Bioturbation, Diatoms, Flagellates, Oxygen requirements, Phosphorus, Preservation, Succession.

The shallow waters of the northern Adriatic cover a more or less smooth part of the continental shelf. According to successive appearance of subfossil diatom, ebridian and silicoflagellate remains found in three sediment cores, levels of dissolution of biogenic opal are determined. Successive entry levels of siliceous organisms could reflect the oxygen history of the basin. On the basis of the better preserved coccolithophorid remains and an absolute time scale provided by excess lead-210 profiles, changes in primary productivity occur. The absence of diatoms with fragile skeletons point out that selective dissolution of opal in the northern Adriatic sediments indeed take place. As appearances of heavily silicified diatoms are not accompanied by other, more delicate diatom taxa, the diatom entry levels seem to show the depths of preservation of biogenic opal in the northern Adriatic sediments. Under anoxic conditions, bioturbation tends to be minimal, and the organic components of the pellets are not oxidized. Both factors strongly increase the preservation potential of the pellets, and, by their protective force, also of the siliceous remains themselves. Entry levels of the various siliceous phytoplankton taxa could indicate the precise moments from which the oxygen concentrations in the bottom environments allowed the permanent preservation of the successive taxa. The sudden increase of all phytoplankton remains in the last 40 years ago is clearly connected with the post-war increase of phosphorus load originating from human activities, particularly from detergents from Italy. In the case of coccolithophorids, the increase is probably real; in the case of siliceous remains, the increase could be caused by preservation potential as a result of the further decreasing oxygen concentrations in the bottom environment. (Brunone-PTT)
W91-03983

SEASONAL OCCURRENCE OF AUTOTROPHIC NAKED NANOFLAGELLATES IN KIEL BIGHT, WESTERN BALTIC.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
F. J. Jochem.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 189-202, August 1990. 2 fig, 3 tab, 49 ref.

Descriptors: *Algae, *Autotrophic algae, *Baltic Sea, *Flagellates, *Kiel Bight, *Phytoplankton, *Plant metabolism, *Red tide, *Sampling, *Seasonal variation, Filtration, Light microscopy, Species diversity.

Nanoplankton may account for 80 to 100% of phytoplankton biomass and productivity during summer, and picoplankton for up to 33%. From April to October 1986, the occurrence of autotrophic, mainly naked nanoflagellates was surveyed qualitatively and semi-quantitatively at four stations in Kiel Bight and Kiel Fjord by use of the dilution culture technique and light microscopy of live preparation. In April, the flagellate community was characterized by species mostly >10 microm (Cryptomonas pseudobaltica, Katodinium rotundatum, Pseudopedinella pyriforme, Heterosigma akashiwo). After a bloom of Dictyocha speculum in May, mainly smaller species occurred during summer (Dicrateria/Imantonia sp., Nephroselmis pyriformis, Ochromonas minima and others). From late August onwards Prorocentrum minimum occurred and formed a red tide in Kiel Fjord. Based on their seasonal occurrence, temperature ranges are derived for each species. Because different flagellate species may exhibit different life strategies and physiological properties, more studies on seasonal succession patterns including species identification at least on a light microscopic level are needed. Since the dilution culture technique is both selective and very time-consuming, concentration of live specimens by the tangential flow filtration may be a valuable tool to get a qualitative or semi-qualitative impression of nanoflagellate populations. (Author's abstract)
W91-03984

MIXING AND CIRCULATION IN THE SUNDAYS RIVER ESTUARY, SOUTH AFRICA.
Port Elizabeth Univ. (South Africa). Inst. for Coastal Research.
H. M. MacKay, and E. H. Schumann.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 203-216, August 1990. 9 fig, 25 ref.

Descriptors: *Estuaries, *Mixing, *South Africa, *Sundays River Estuary, *Tidal currents, *Water circulation, Salinity, Seasonal variation, Stratification, Water temperature.

In the winter of 1987, a field exercise of 6 weeks' duration was carried out to investigate tidal dynamics and circulation patterns in the Sundays River estuary, on the south east coast of South Africa. Measurements included continuous monitoring of water levels inside and outside the estuary, salinity and temperature profiles along the estuary at slack tides, current velocity profiles and near-bottom currents. The estuary was found to be in a highly stratified state at neap tides, but became completely mixed at spring tides. Dynamically, the estuary can be divided into four longitudinal sections, each with an essentially different circulation pattern. Stratification and mixing in the water column appears to depend on semidiurnal tides in the local coastal ocean; the spring-neap tidal cycle; and freshwater input. Direct effects of wind mixing were not observed. Frequent visual observations of the phenomena of axial convergence are supported by water temperature and current velocity data. (Author's abstract)
W91-03985

DIMETHYL SULFIDE PRODUCTION FROM DIMETHYLSULFONIOPROPIONATE IN COASTAL SEAWATER SAMPLES AND BACTERIAL CULTURES.
Georgia Univ., Sapelo Island. Marine Inst.
For primary bibliographic entry see Field 2K.
W91-04064

ADVECTION OF EUPHAUSIIDS IN A NORWEGIAN FJORD SYSTEM SUBJECT TO ALTERED FRESHWATER INPUT BY HYDROELECTRIC POWER PRODUCTION.
Bergen Univ. (Norway). Dept. of Fisheries and Marine Biology.
For primary bibliographic entry see Field 6G.
W91-04112

PCB MOVEMENT, DECHLORINATION, AND DETOXICATION IN THE ACUSHNET ESTUARY.
General Electric Co., Schenectady, NY. Research and Development Center.
For primary bibliographic entry see Field 5B.
W91-04141

OXIDATION AND REDUCTION OF RADIOLABELED INORGANIC SULFUR COMPOUNDS IN AN ESTUARINE SEDIMENT, KYSING FJORD, DENMARK.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2K.
W91-04155

INVESTIGATION OF THE ALLOCATION OF SAMPLING STATIONS DURING ESTUARINE SURVEYS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W91-04198

IMPORTANCE OF SPHEROIDAL CARBONACEOUS PARTICLES (SCPS) FOR THE DISTRIBUTION OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN AN ESTUARINE-LIKE URBAN COASTAL WATER AREA.
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W91-04249

SUB-RECENT BRYOZOAN-SERPULID BUILDUPS IN THE COORONG LAGOON, SOUTH AUSTRALIA.
Adelaide Univ. (Australia). Dept. of Geology and Geophysics.

Y. Bone, and R. E. Wass.
Australian Journal of Earth Sciences AJESE7, Vol. 37, No. 2, p 207-214, June 1990. 9 fig, 1 tab, 26 ref.

Descriptors: *Australia, *Ecological effects, *Estuaries, *Estuarine environment, *Invertebrates, *Lagoons, *Marine animals, *Paleoecology, Bryozoans, Colonization, Ecological distribution, Hypersalinity, Intertidal areas, Radioactive dating, Reefs, Serpulids, Species diversity, Subtidal areas, Succession, Temperature effects, Water depth.

Genera and/or species in any particular area are controlled by environmental factors such as water depth, salinity, nutrient availability, substrate and the presence of other fauna and/or flora more opportunistic than themselves. A study was undertaken to describe small but lateral extensive buildups composed of a bryozoan (Membranipora aciculata) and serpulid worms in the Coorong lagoon, South Australia, and to interpret their origin, climatic and environmental significance. The use of 14C dating indicated that the main growth phase of the buildups was a Late Holocene phenomenon which took place some 700 years ago. Field evidence indicated that since then there has been a gradual reversal of the dominant organism forming the buildups during the geologically short period. In the sub-Recent, M. aciculata was dominant, whereas now serpulids dominate the scene. The buildups, once established, did not follow the normal succession pattern in which colonization was followed by rapid and complex diversification, leading to a climax population. Rather, the buildups only consisted of two organisms. This limited assemblage suggests that the Coorong was already an inhospitable environment at the time of colonization, some 700 years ago. Based on a study of the ecology of the area, it appears that the environment of the lagoon changed from subtidal to intertidal during the last 700 years. In addition, it is unusual for bryozoan deposits to be monospecific. This monospecificity suggests an element of chance was involved in the colonization of this harsh environment, and emphasizes the fragility of its maintenance. (Korn-PTT)
W91-04272

COMPUTER SIMULATION OF TIDE-INDUCED RESIDUAL TRANSPORT IN A COASTAL LAGOON.
Harbor Branch Inst., Inc., Fort Pierce, FL.
N. P. Smith.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 10, p 18,205-18,211, October 15, 1990. 2 fig, 4 tab, 19 ref.

Descriptors: *Coastal lagoons, *Florida, *Indian River Lagoon, *Model studies, *Simulation analysis, *Tidal currents, *Water transport, Computer models, Flow characteristics, Mass transport, Residual flow, Tidal waves, Water circulation.

A two-dimensional, four-layer numerical model of tidally induced residual flow was used to quantify longitudinal transport through the interior of Indian River lagoon, on Florida's Atlantic coast. Water depths and surface slopes at the approximate midpoint between two inlets were calculated by assuming that the tide in the interior of the lagoon is the superposition of exponentially damped sine waves representing six tidal constituents. Tidal waves moving south from one inlet are modified significantly by the same six constituents moving north from a second inlet. The net slope as they pass through each other at the study site quantifies the barotropic pressure gradient. Tidal period variations in longitudinal flow were simulated as a response to the barotropic pressure gradient, vertical eddy viscosity, and horizontal and vertical advective accelerations. The model was tuned and simplifications were verified by comparing amplitudes and phase angles with values computed from currents and water levels measured over a 65-day period in the summer of 1981. Results indicated a depth-averaged tidally induced residual flow of 0.8 cm/s at the study site. The residual flow varied from 0.1 to 1.2 cm/s over a synodic lunar month. Just under two-thirds of the total is explained by Stokes transport; Eulerian mass transport contributes slightly more than one-third. The total mass transport residual current through individual layers decreased from 1.0 cm/s in the top layer to 0.6 cm/s in the lowest 75 cm. An analysis of individual terms in the momentum equation indicated that the force balance is dominated by the barotropic pressure gradient and vertical eddy viscosity forces. The significance of tidally induced residual flow lies in the baseline level of transport it provides at times of low wind speeds. (Author's abstract)
W91-04295

SETTLING SPEED OF FLOCS IN FRESH WATER AND SEAWATER.
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
For primary bibliographic entry see Field 2J.
W91-04296

CURRENT AND SEA LEVEL VARIABILITY IN THE CHESAPEAKE AND DELAWARE CANAL.
Delaware Univ., Newark. Coll. of Marine Studies.
K. C. Wong.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 10, p 18,343-18,352, October 15, 1990. 8 fig, 2 tab, 10 ref. NSF Grant OCE-8515735 and NOAA Office of Sea Grant NA85AA-D-SG033.

Descriptors: *Chesapeake and Delaware Canal, *Sea level, *Tidal amplitude, *Tidal currents, *Tides, Delaware Bay, Diurnal variation, Frequency distribution, Model studies, Water transport.

Current and sea level observations in the Chesapeake and Delaware (C and D) Canal were used to examine the frequency-dependent spatial distributions of tidal and subtidal variability along the canal. To first order of approximation, the C and D Canal was shown to be a linear system. A linearized, frequency-dependent analytical model was developed to examine details in the tidal and subtidal variability along the canal, and results agreed well with observations. The principal semidiurnal tides (M2) at the two ends of the canal are roughly in phase, but differ substantially in amplitude. The amplitude of the M2 tide increases monotonically from the Chesapeake end of the canal toward the Delaware end. The amplitude of the M2 current is on the order of 60 cm/s, and it is higher in the western part of the canal than in the eastern part. The amplitudes of the principal diurnal tides (K1) at the two ends of the canal are much smaller than those for M2, but the K1 tides at the ends are nearly 180 degrees out of phase with each other. The amplitude of the K1 tide decreases toward the interior of the canal from both ends. Relatively strong K1 current on the order of 20 cm/s exists in the canal, and its amplitude shows only slight variation along the canal. There are substantial differences in the subtidal sea level fluctuations along the canal, resulting in strong subtidal currents which may exceed 70 cm/s. The importance of the C and D Canal to the upper Delaware Bay was assessed by comparing the volume flux through the canal relative to that in the upper Delaware. It was shown that the influence of the canal on the Delaware depends strongly on the time scales involved. It appears that the C and D Canal is not important to the overall tidal response in upper Delaware Bay, but the subtidal volume flux through the canal must be included for a proper assessment of the dynamics of upper Delaware Bay at subtidal frequencies. (Author's abstract)
W91-04297

NOTE ON THE ATTENUATION OF SURFACE GRAVITY WAVES BY RAINFALL.
Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
J. A. Nystuen.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 10, p 18,353-18,355, October 15, 1990. 1 fig, 13 ref.

Descriptors: *Gravity waves, *Ocean waves, *Radar, *Rainfall, *Surface water, *Water surface profiles, Attenuation, Mathematical models, Remote sensing, Turbulent flow, Wavelengths.

Rainfall has long been associated with damping of short surface gravity waves. A theory is presented which uses a thin rain-induced turbulent surface layer to explain the enhanced attenuation. In the presence of a thin turbulent surface layer, the e-folding attenuation time for the 30 cm wavelength surface gravity waves needed for remote sensing of the ocean surface using synthetic aperture radar (SAR) is reduced from several minutes to several seconds. This explains the observation of low SAR radar return from regions of high rainfall. Longer wavelengths are also affected depending on the strength of the mixing and the thickness of the turbulent layer. (Author's abstract)
W91-04298

PARTITIONING OF UNSUBSTITUTED POLYCYCLIC AROMATIC HYDROCARBONS BETWEEN SURFACE SEDIMENTS AND THE WATER COLUMN IN THE BRISBANE RIVER ESTUARY.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 5B.
W91-04361

CYTOLOGICAL STUDY OF VACUOLATED CELLS AND OTHER ABERRANT HEPATOCYTES IN WINTER FLOUNDER FROM BOSTON HARBOR.
Rhode Island Univ., Kingston. Coll. of Resource Development.
For primary bibliographic entry see Field 5C.
W91-04363

APPLICATION OF FACTOR ANALYSIS TO THE HYDROGEOCHEMICAL STUDY OF A COASTAL AQUIFER.
Alicante Univ. (Spain). Div. de Ingenieria Quimica.
For primary bibliographic entry see Field 2F.
W91-04397

DAY-TO-DAY VARIABILITY IN THE PLANKTON COMMUNITY OF A COASTAL SHALLOW EMBAYMENT IN RESPONSE TO CHANGES IN RIVER RUNOFF AND WATER TURBULENCE.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
C. Garcia-Soto, I. de Madariaga, F. Villate, and E. Orive.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 217-229, September 1990. 6 fig, 3 tab, 22 ref.

Descriptors: *Plankton, *Population dynamics, *Runoff, *Spain, *Turbulence, Animal behavior, Bay of Plencia, Diatoms, Nutrients, Phytoplankton, Primary productivity, Saline-freshwater interfaces, Zooplankton.

The day-to-day variations over a 17-day period in the plankton community of a shallow embayment located in the Bay of Plencia (Cantabric Sea, Spain, adjacent to the Bay of Biscay) were studied and related to changing environmental conditions. Fluctuations in river runoff due to several rain pulses determined most of the changes in the chemical properties of the embayment. Other physical forcing functions, such wave-originated high turbulence in the water column, regulated the quantity and quality of seston and chlorophyll a. As a response to the combined effects of these processes, different patterns of variation were observed in phyto-, and zooplankton populations. Skeletonema costatum developed after nutrient inputs into the system and resulted in enhanced primary production levels. Population growth also was controlled by turbulence, whereas the disappearance of this pulse could be associated with the depletion of silicate. Zooplankton abundance fluctuations can be explained mainly by the motility of these organisms, which permits them to avoid the environmental stress imposed by water turbulence and sediment resuspension. (Author's abstract)
W91-04412

TIME-DEPENDENT, THREE-DIMENSIONAL MODEL OF THE DELAWARE BAY AND RIVER SYSTEM: PART 1. DESCRIPTION OF THE MODEL AND TIDAL ANALYSIS.

Princeton Univ., NJ. Program in Atmospheric and Oceanic Sciences.
B. Galperin, and G. L. Mellor.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 231-253, September 1990. 11 fig, 2 tab, 29 ref. NOAA Grant NA84EAD00057.

Descriptors: *Continental shelf, *Delaware Bay, *Delaware River, *Estuaries, *Estuarine environment, *Model studies, *Tides, Mathematical models, Numerical analysis, Three-dimensional model, Tidal amplitude.

A three-dimensional, time-dependent numerical model is used to simulate the dynamics and thermodynamics of Delaware Bay, Delaware River, and the adjacent continental shelf. This represents the first attempt to model an estuary and the continental shelf as a coupled hydrodynamic and thermodynamic system. Numerical results of the model were compared with surface elevation data at several locations throughout the Bay and River and with observations collected by the National Ocean Service during their 1984-1985 circulatory study. A vertically integrated, two-dimensional version of the model predicts realistic amplitudes but with some phase error. The full three-dimensional version of the model reduces the phase error, but underpredicts the tidal range. This is due to the higher values of horizontal viscosity required by the three-dimensional model. The model accounts for non-linear, shallow-water effects and reproduces the observed amplification of the high-frequency tidal components from the mouth of the Bay to the head of the estuary at Trenton, NJ. (See also W91-04414) (Author's abstract)
W91-04413

TIME-DEPENDENT, THREE-DIMENSIONAL MODEL OF THE DELAWARE BAY AND RIVER SYSTEM: PART 2. THREE-DIMENSIONAL FLOW FIELDS AND RESIDUAL CIRCULATION.

Princeton Univ., NJ. Program in Atmospheric and Oceanic Sciences.
B. Galperin, and G. L. Mielor.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 255-281, September 1990. 19 fig, 1 tab, 12 ref. NOAA Grant NA84EAD00057.

Descriptors: *Continental shelf, *Delaware Bay, *Delaware River, *Estuaries, *Estuarine environment, *Model studies, *Tidal currents, *Tides, *Water circulation, Gulf Stream, Mathematical models, Numerical analysis, Salinity, Three-dimensional model.

A three-dimensional, time-dependent, numerical model of the Delaware Bay, Delaware River, and adjacent continental shelf is capable of realistic simulation of current and salinity distributions, tidal cycle variability, events of strong mixing caused by high winds, and rapid salinity changes due to high river runoff. The 25-hr average subtidal circulation depends strongly on the wind forcing. Monthly residual currents and salinity distributions demonstrate a classical two-layer estuarine circulation wherein water of relatively low salinity flows at the surface and compensating water of high salinity from the shelf flows at the bottom. The salinity intrusion is most vigorous along deep channels in the Bay. Winds can generate salinity fronts inside and outside the Bay and enhance or weaken the two-layer circulation pattern. Since the portion of the continental shelf included in the model is limited, the model shelf circulation is locally wind-driven and excludes such effects as coastally trapped waves and interaction with Gulf Stream rings. Nevertheless, a significant portion of the coastal elevation variability is hindcast by the model. Also, inclusion of the shelf improves simulation of salinity inside the Bay compared with simulations where the salinity boundary condition is specified at the mouth of the Bay. (See also W91-04413) (Author's abstract)
W91-04414

PHYSICAL CHARACTERISTICS OF THE BAHIA BLANCA ESTUARY (ARGENTINA).

Instituto Argentino de Oceanografia, Bahia Blanca.
M. C. Piccolo, and G. M. E. Perillo.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 303-317, September 1990. 14 fig, 28 ref. Consejo Nacional de Investigaciones Cientificas y Tecnicas (Argentina) Grants PID 3901501/85 and PID 3901502/85.

Descriptors: *Argentina, *Estuaries, *Estuarine environment, *Salinity, *Temperature, *Tidal currents, Bahia Blanca Estuary, Evaporation, Mass transport, Saline-freshwater interfaces, Salt flats, Tides.

Temperature, salinity, and current velocity and direction data were obtained for the Bahia Blanca Estuary (Argentina). Data were gathered in vertical profiles made in longitudinal as well as in hourly surveys. Freshwater runoff averages 2 cu m/sec, but peak floods can reach 10-50 cu m/sec. The temperature distribution is quite homogeneous in the estuary. Based on the salinity distribution, the estuary can be divided into two sectors: an inner one showing partially mixed characteristics with a strong tendency to become sectionally homogeneous during runoff conditions similar to the historical averages, and an outer sector that is sectionally homogeneous. Salinity values in the inner sector may be larger than those observed in the inner continental shelf. This is initiated by the restricted circulation in the inner estuary and added to by the tidal washing of back-estuary salt flats and by evaporation processes. Analysis of the residual circulation shows a marked difference in the direction of mass transport. In the deeper regions of the sections (northern flank) the flow reverses with depth, being headward near the bottom. However, net transport is landward in the shallower parts. (Author's abstract)
W91-04415

TIDAL DYNAMICS IN A COUPLED OCEAN/LAKE SYSTEM.

Dartmouth Coll., Hanover, NH.
D. R. Lynch, F. E. Werner, J. M. Molines, and M. Fornerino.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 319-343, September 1990. 17 fig, 4 tab, 32 ref. NSF Grants INT-8514156 and CEE-8352226.

Descriptors: *Gulf of Venezuelo, *Estuaries, *Venezuela, *Tides, *Model studies, Mathematical models, Tidal currents, Three-dimensional model, Two-dimensional model, *Lake Maracaibo, Tablazo Bay, Waves.

Barotropic tides were studied in the Lake Maracaibo system, Venezuela. The system consists of two larger water bodies, the Gulf of Venezuela and Lake Maracaibo, connected by the Strait of Maracaibo and Tablazo Bay. The dominant semi-diurnal tide resonates in the gulf and co-oscillates roughly 180 degrees out of phase in the lake. The narrow strait and shallow bay regulate their dynamical interaction. Two-dimensional and three-dimensional finite element models are used in conjunction with a fresh analysis of tidal data at seven stations, several of which lie in the strait and bay. A coupled model of the whole system is necessary to properly interpret these data, which show the influence of small-scale, near-field effects superimposed on the larger-scale dynamics of the gulf and lake. The detailed geometry at the connections with the gulf and the lake also plays a significant role in the local response in the strait and bay. Cotidal charts are presented for nine major astronomical and shallow water tidal constituents found in the data. The velocity structure derived under simple eddy viscosity assumptions is highly dynamic. A characteristic phase lead is found in velocities at depth and near the shore, where vertical shear dominates over inertia in the force. (Author's abstract)
W91-04416

FLUSHING OF A COASTAL LAGOON IN THE RED SEA.

King Abdulaziz Univ., Jeddah (Saudi Arabia). Faculty of Marine Science.
S. A. R. Sultan, and F. Ahmad.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 3, p 345-349, September 1990. 1 fig, 1 tab, 13 ref. King Abdulaziz University Grant 015/1409.

Descriptors: *Coastal lagoons, *Flushing, *Saudi Arabia, *Tides, Aquaculture, Arid zone, Hypersalinity, Red Sea, Seasonal distribution, Shu'aiba Lagoon.

Shu'aiba Lagoon (lat. 20 deg 45 min N, long. 39 deg 28 min E) is located on the eastern coast of the Red Sea (Saudi Arabia). It is relatively shallow with an area of approximately 11.7 sq km. The inlet to the lagoon is narrow, with a cross-sectional area of about 245 sq m. This lagoon is a future site for mariculture development. With this objective in view, the flushing time scale of the lagoon was calculated, as flushing is an important abiotic factor in lagoon ecology. The average flushing time for the months February to June and September to November is about 20 days. Oceanic inputs play an important part in the process of fertilization of the lagoons. The marine environment in arid zone lagoons is under natural stress due to high temperatures and salinities. However, the flushing time scale of 20 days may not exert intolerable stress on the ecology of the Shu'aiba Lagoon. (Author's abstract)
W91-04417

PRODUCTIVITY AND NUTRIENT RELATIONSHIPS IN PSAMMOPHYTIC VERSUS EPILITHIC FORMS OF BRYOPSIDALES (CHLOROPHYTA): COMPARISONS BASED ON A SHORT-TERM PHYSIOLOGICAL ASSAY.

National Museum of Natural History, Washington, DC. Dept. of Botany.
M. M. Littler, and D. S. Littler.

Hydrobiologia HYDRB8, Vol. 204/5, p 49-55, September 28, 1990. 2 fig, 46 ref.

Descriptors: *Algae, *Aquatic habitats, *Aquatic productivity, *Chlorophyta, *Corals, *Limiting nutrients, *Reefs, Nitrogen, Phosphorus, Photosynthesis, Physiological ecology, Plant physiology.

Members of the green algal order Bryopsidales (= Caulerpales) are important calcifying agents of tropical reefs and comprise two fundamentally different life-form groups: (1) epilithic species with limited attachment structures and (2) psammophytic forms that have extensive subterranean rhizoidal systems. Because the shallow-water habitats of the former have relatively low N and inorganic P ratios compared to the pore waters of the sedimentary carbonate-rich substrata in which the latter are anchored, it was hypothesized that epilithic forms should tend to be relatively more limited by N, whereas psammophytic species should tend to show inorganic P limitation. In partial support the hypothesis, light-saturated net photosynthesis (Pmax) in the epilithic forms, Halimeda opuntia, H. lacrimosa, and H. copiosa, tended to be enhanced by N, whereas inorganic P was inhibitory or had no effect. In contrast, the psammophytic forms, Udotea sp., U. conglutinata, H. monile, H. tuna, and H. simulans, tended to be stimulated more by inorganic P, whereas N had little effect. The utility of a bioassay to assess macroalgal nutrient limitation, based on a physiological response (net Pmax) to short-term nutrient pulses, is demonstrated. (Author's abstract)
W91-04419

EFFECTS OF ACID WASTES FROM TITANIUM DIOXIDE PRODUCTION ON BIOMASS AND SPECIES RICHNESS OF BENTHIC ALGAE.

Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W91-04420

CANOPY CHARACTERISTICS OF THE BROWN ALGA SARGASSUM MUTICUM (FU-

CALES, PHAEOPHYTA) IN LAKE GREVELINGEN, SOUTHWEST NETHERLANDS.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Botany.
A. T. Critchley, P. R. M. De Visscher, and P. H. Nienhuis.
Hydrobiologia HYDRB8, Vol. 204/5, p 211-217, September 28, 1990. 3 fig, 2 tab, 28 ref.

Descriptors: *Algae, *Aquatic populations, *Aquatic productivity, *Introduced species, *Phaeophyta, *Sargassum, *The Netherlands, Lake Gevelingen, Lake Veere, Photosynthesis, Primary productivity, Scheldt Estuary, Shading, Water temperature.

The distribution of the invasive brown alga Sargassum muticum in the southwest Netherlands was determined. Populations of the alga were found to have remained at their 1985 level in Lake Grevelingen, with a small eastward expansion into the Eastern Scheldt estuary. A new population for the brackish, non-tidal Lake Veere was detected. Within Lake Grevelingen S. muticum forms a persistent, extensive canopy of 100% cover (4442.5 + or -525.6 g fresh wt/sq m; 640.3 + or -75.8 g dry wt/sq m) that has a marked effect upon the penetration of photosynthetically active radiation (PAR) (reduced by 97% at 0.1 m). Surface sea water temperatures can be elevated by 2.7 C above water not associated with a Sargassum canopy; furthermore, the dense canopy shades and hence reduces water temperatures below 0.1 m depth. Productivity studies indicate that assimilation occurs in the upper levels of the canopy (57.09 micrograms C/mg dry wt/sq m at a mean PAR rate of 016.7 Joules/sq cm/hr). Self-shading and a resultant decrease in the rate of assimilation was evident below the canopy. (Author's abstract)
W91-04421

ABUNDANCE CHANGES IN LAMINARIA SETCHELLII AND PTERYGOPHORA CALIFORNICA (LAMINARIALES, PHAEOPHYTA) NEAR THE DIABLO CANYON POWER PLANT.
California Inst. of Tech., Pasadena. W.M. Keck Engineering Lab. of Hydraulics and Water Resources.
For primary bibliographic entry see Field 5C.
W91-04422

ECONOMICALLY IMPORTANT SEAWEEDS IN MAR PICCOLO, TARANTO (SOUTHERN ITALY): A SURVEY.
Istituto Sperimentale Talassografico 'Attilio Cerruti', Taranto (Italy).
For primary bibliographic entry see Field 5C.
W91-04423

TOXICITY OF SEWAGE-CONTAMINATED SEDIMENT CORES TO MACROCYSTIS PYRIFERA (LAMINARIALES, PHAEOPHYTA) GAMETOPHYTES DETERMINED BY DIGITAL IMAGE ANALYSIS.
California Inst. of Tech., Pasadena. W.M. Keck Engineering Lab. of Hydraulics and Water Resources.
For primary bibliographic entry see Field 5C.
W91-04424

ESTUARY SEDIMENTS OF THE YOSHINO RIVER--STUDY ON ESTUARY SEDIMENTS, PART 2.
Kochi Univ. (Japan). Dept. of Geology.
T. Mitusio, and N. Hirai.
Bulletin of Marine Sciences and Fisheries, Kochi University, No. 11, p 69-77, December 1989. 6 fig, 2 tab, 17 ref. English summary.

Descriptors: *Estuaries, *Japan, *Sediment chemistry, *Sediments, *Yoshino River, Grain size, Organic matter.

Estuary sediments of the Yoshino River locating in Tokushima City were studied. Seven sediments collected are rather well-sorted medium sand, and are mostly composed of non-bioclastic sediments with a small amount of bioclastics such as shell fragments. The contents of carbon and nitrogen increase as the mud increases. (Author's abstract)
W91-04439

TIDAL VELOCITY ASYMMETRIES AND BED-LOAD TRANSPORT IN SHALLOW EMBAYMENTS.
Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 2J.
W91-04459

DISTRIBUTION AND COMPOSITION OF SUSPENDED PARTICULATE MATERIAL IN THE CLYDE ESTUARY AND ASSOCIATED SEA LOCHS.
Marine Lab., Aberdeen (Scotland).
P. W. Balls.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 5, p 475-487, May 1990. 6 fig, 4 tab, 43 ref.

Descriptors: *Clyde Estuary, *Estuaries, *Organic matter, *Sediments, *Suspended sediments, *Suspended solids, *Trace metals, Firth of Clyde, Seasonal variation, Sediment chemistry, Water chemistry, Water depth.

The composition of suspended particulate material (SPM) from the Clyde Estuary and the Firth of Clyde (including its sea lochs) has been investigated. The concentration in SPM of particulate organic carbon (POC), iron, manganese, zinc, lead, copper, and cadmium are reported. High POC concentrations in surface waters were associated with phytoplankton. Surface water SPM contained higher concentrations of cadmium and zinc than that from deeper waters. By contrast, concentrations of iron, manganese, lead, and copper (enriched in crustal material relative to phytoplankton) were higher in subsurface SPM. Trace metal concentrations in SPM were better correlated to iron than to manganese. Estuarine particles were enriched in trace metals relative to other areas, the higher iron concentrations in the estuary were, however, insufficient to account for this enrichment. Seasonal variability in the trace metal composition of surface SPM should be revealed through careful study. Elements enriched in crustal material show higher concentrations in winter than in spring. (Author's abstract)
W91-04460

NITRATE AND AMMONIUM UPTAKE BY PHYTOPLANKTON POPULATIONS DURING THE SPRING BLOOM IN AUKE BAY, ALASKA.
Oceanic Inst., Waimanalo, HI.
For primary bibliographic entry see Field 2H.
W91-04461

GROUND-WATER FLOW IN THE NEW JERSEY COASTAL PLAIN.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04471

SEA LEVEL RISE AND FRINGE WETLANDS IN NORTH CAROLINA: RECOMMENDATIONS FROM A WORKSHOP ON MANAGEMENT AND RESEARCH.
East Carolina Univ., Greenville, NC. Dept. of Biology.
M. M. Brinson, and K. K. Moorhead.
Journal of the Elisha Mitchell Scientific Society JEMSA5, Vol. 105, No. 4, p 149-157, Winter 1989. 9 ref. DOE Contract DE-AC09-76FR00-819.

Descriptors: *Estuaries, *Global warming, *North Carolina, *Sea level, *Wetlands, *Workshops, Climates, Ditches, Erosion, Reservoirs, Resource management, Shoreline, Shores, Water circulation.

At a workshop held on March 1, 1989, recommendations were made for management and research on the wetlands that occupy much of the estuarine shorelines in North Carolina. Acceleration in the rate of sea level rise caused by global warming will alter the location and quality of fringe wetlands in the state. Management recommendations fell into two categories: those that are possible with current frameworks and those that will require changes in existing regulations. The first category can be implemented largely by understanding the short and long term implications of sea level rise for coastal wetlands and adjacent regions. Planning will require cost-benefit analyses, better estimation of sea level rise, updating maps of 'flood-prone areas', creative approaches to wildlife, fisheries, and silviculture management in the flood plain. The second category will require removal of incentives for wetland alteration and creation of disincentives for activities that interfere with shorelines processes important to wetland maintenance. Research is needed to reduce the many uncertainties that exist on rates and timing of sea level rise, site-specific changes in shoreline position and erosion rates, and the influence of larger scale phenomena such as climatic patterns and oceanic circulation on wetland ecosystems. Rates of accretion of wetland surfaces; effects of alterations such as ditches, impoundments, and altered hydrology; and the ecological role of wetlands on a landscape scale are a few of the issues which need to be addressed. (Brunone-PTT)
W91-04512

INFLUENCE OF PIG FARMING ON THE COPPER CONTENT OF ESTUARINE SEDIMENTS IN BRITTANY, FRANCE.
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest. Dept. Environnement Littoral.
For primary bibliographic entry see Field 5B.
W91-04515

COMPARISON OF TRACE METALS DATA IN MUSSELS AND OYSTERS FROM A MUSSEL WATCH PROGRAMME OF THE 1970S WITH THOSE FROM A 1980S PROGRAMME.
National Ocean Service, Rockville, MD.
For primary bibliographic entry see Field 5B.
W91-04517

PETROLEUM AROMATIC HYDROCARBONS IN SURFACE WATERS AROUND ELEPHANT ISLAND, ANTARCTIC PENINSULA.
Sao Paulo Univ. (Brazil). Inst. Oceanografico.
For primary bibliographic entry see Field 5B.
W91-04518

DISSOLVED ARSENIC IN THE ST. LAWRENCE ESTUARY AND THE SAGUENAY FJORD, CANADA.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
For primary bibliographic entry see Field 5B.
W91-04519

KELP RESPONSE FOLLOWING THE WORLD PRODIGY OIL SPILL.
Smith Coll., Northampton, MA. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-04521

BENTHOS ON TAILINGS BEDS FROM AN ABANDONED COASTAL MINE.
Victoria Univ. (British Columbia). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-04522

MERSEY OIL SPILL, AUGUST, 1989: A CASE OF SEDIMENTS CONTAMINATING THE OIL.
Liverpool Univ. (England). Oceanography Lab.
For primary bibliographic entry see Field 5B.
W91-04523

CU AND CD ASSOCIATED WITH SUSPENDED PARTICULATE MATTER IN TORRES STRAIT.
Sydney Univ. (Australia). Ocean Sciences Inst.
For primary bibliographic entry see Field 5B.
W91-04524

TRACE METAL CONCENTRATIONS IN MANGROVE OYSTER (CRASSOSTREA CORTEZIENSIS) FROM TROPICAL LAGOON ENVIRONMENTS, MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
For primary bibliographic entry see Field 5B.
W91-04525

SEX- AND MATURITY-RELATED HEAVY METAL ACCUMULATIONS IN THE ANTARCTIC KRILL EUPHAUSIA SUPERBA.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
For primary bibliographic entry see Field 5B.
W91-04530

SELENIUM AND OTHER ELEMENTS IN JUVENILE STRIPED BASS FROM THE SAN JOAQUIN VALLEY AND SAN FRANCISCO ESTUARY, CALIFORNIA.
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
For primary bibliographic entry see Field 5B.
W91-04577

OBSERVATIONS ON DOUBLE CHLOROPHYLL MAXIMA IN THE VICINITY OF THE FRASER RIVER PLUME, STRAIT OF GEORGIA, BRITISH COLUMBIA.
British Columbia Univ., Vancouver. Dept. of Oceanography.
W. P. Cochlan, P. J. Harrison, P. J. Clifford, and K. Yin.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 143, No. 1/2, p 139-146, October 30, 1990. 2 fig, 17 ref.

Descriptors: *Algal blooms, *British Columbia, *Chlorophyll, *Estuarine environment, *Phytoplankton, *Plumes, *Population dynamics, *River mouth, *Saline-freshwater interfaces, Advection, Chemical analysis, Fraser River, Halocline, Nutrients, Strait of Georgia, Thermocline, Vertical distribution, Water sampling.

During a cruise to study nutrient and phytoplankton dynamics in the vicinity of the Fraser River plume, vertical profiles of in vivo fluorescence, temperature, salinity, nitrate and silicate were taken. Double chlorophyll maxima at 4 to 6 and 12 to 14 m were observed only during the late flood tide at two stations on one day and at one station the following day during the 11 day cruise. Accompanying vertical profiles of nitrate and silicate at two stations showed concentrations minima at depths corresponding approximately to the chlorophyll maxima. The upper chlorophyll maximum occurred at the base of the thermocline and halocline and at the beginning of the nitracline, while the lower, chlorophyll maximum was not associated with any features in the temperature or salinity vertical profiles, although minima in nitrate and silicate were associated with it. The most plausible explanation for the observed double chlorophyll maxima is that the upper chlorophyll minimum formed in plume water while the lower chlorophyll minimum originated in waters seaward of the plume and was advected to the plume area during flood tides and possibly entrained into the plume as the freshwater plume flowed seaward. Hence both maxima probably formed due to nitrogen limitation of the surface waters, but at two different depths and flood tides superimposed the two maxima on top of each other due to density differences in the two water masses. These observations suggest that double chlorophyll maxima may only be observed in this riverine plume front during late flood tides and only if a relatively deep (i.e., deeper than the plume maximum) chlorophyll maximum is formed in waters beyond the plume. Other plausible causes include interweaving water masses, successive phytoplankton blooms, selective zooplankton grazing, sampling error, and vertically migrating dinoflagellates and flagellates. (Author's abstract)
W91-04633

NITZSCHIA PSEUDODELICATISSIMA: A SOURCE OF DOMOIC ACID IN THE BAY OF FUNDY, EASTERN CANADA.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
J. L. Martin, K. Haya, L. E. Burridge, and D. J. Wildish.
Marine Ecology Progress Series MESEDT, Vol. 67, No. 2, p 177-182, October 18, 1990. 2 fig, 2 tab, 15 ref.

Descriptors: *Algal toxins, *Bay of Fundy, *Clams, *Diatoms, *Estuarine environment, *Marine algae, *Mussels, *Toxins, Bioaccumulation, Biological magnification, Food poisoning, Mollusks, Path of pollutants.

Domoic acid has been indentified as the cause of food poisoning from consumption of shellfish in Canada. Circumstantial evidence shows that domoic acid detected in softshell clams Mya arenaria and blue mussels Mytilus edulis from the southwestern Bay of Fundy, eastern Canada, during July to October 1988 was obtained by feeding on the pennate diatom Nitzschia pseudodelicatissima. This microalga was the most abundant organism observed in the weekly samples collected at the surface, 10 m depth, and bottom from nearly all of the 19 locations sampled during the same period. Phytoplankton net hauls consisting principally of N. pseudodelicatissima contained domoic acid levels of up to 3.5 micrograms/g. Isolates of 9 dominant phytoplankton species occurring in the southwestern Bay of Fundy during July to October 1988 were cultured and tested for the presence of domoic acid; only N. pseudodelicatissima cultures produced the toxin at concentrations of .007 picograms to .098 picograms/cell. Since cultures of N. pseudodelicatissima were not axenic, the possibility exists that either an intra or extracellular microorganism is acting independently, or in association with the diatom, to produce domoic acid. (Author's abstract)
W91-04720

DISTRIBUTION AND ABUNDANCE OF PACHYMELANIA AURITA IN LAGOS LAGOON, NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W91-04741

ENHANCED PRIMARY PRODUCTION AT THE PLUME/OCEANIC INTERFACE OF THE MISSISSIPPI RIVER.
University of Southern Mississippi, Bay St. Louis. Center for Marine Science.
S. E. Lohrenz, M. J. Dagg, and T. E. Whitledge.
Continental Shelf Research CSHRDZ, Vol. 10, No. 7, p 639-664, July 1990. 12 fig, 4 tab, 69 ref. ONR Contract N00014-88-K-0155.

Descriptors: *Estuaries, *Mathematical models, *Mississippi River, *Plumes, *Primary productivity, Biomass, Light penetration, Nutrients, Phytoplankton, Saline-freshwater interfaces, Salinity.

Mechanistic and empirical models were used to examine relationships between primary production and environmental variables along the Mississippi River plume/oceanic gradient off Southwest Pass, Louisiana. A large proportion of variation in primary production could be explained on the basis of light and biomass. However, comparison of observed chlorophyll concentrations with those predicted using a steady-state light limitation model suggested factors in addition to light availability constrained maximum biomass levels in the plume. Factors which may have contributed to low observed biomass included growth limitation or inhibition by substances not measured, losses due to grazing and sinking, and a short residence time for plume waters, which may have prevented populations from reaching steady state. The dissipative effects associated with plume/oceanic mixing may have been enhanced by potential inhibitory effects of large and varying salinity gradients. Nutrient-salinity distributions, in conjunction with approximate calculations of primary consumption of riverine nutrient sources by phytoplankton, suggested that biomass and production were controlled by nutrient supply at salinities above 30. (Author's abstract)
W91-04742

WERNER SCHNESE AND THE DEVELOPMENT OF COASTAL WATERS ECOLOGY IN ROSTOCK, GDR.
Rostock Univ. (German D.R.). Dept. of Biology.
U. Schiewer.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 1, p 1-13, 1990. 11 fig, 1 tab, 22 ref.

Descriptors: *Baltic Sea, *Coastal waters, *Ecology, *Ecosystems, *Germany, Aquatic bacteria, Brackish water, Enzymes, Fish, Food chains, Model studies, Zooplankton.

A survey was made on the coastal water ecosystems of the Darss-Zingst Bodden chain, a chain of shallow estuarine waters on the southern coast of the Baltic Sea. Studies clarifying the ammonia rhythm of field cyanobacteria populations indicated that, under growth limited conditions and NH4 surplus, there is clearly an NH4 pool, the formation and reduction of which requires energy, and which is regulated by the glutamine synthetase-glutamate synthase pathway. Assessment of the biomass and potential photosynthetic activity of cyanobacteria by use of in situ fluorescence method underestimated the cyanobacteria. Exact measurement is only possible through activation of the chlorophyll fluorescence at wavelength 620 nm. Population ecology studies have been completed on the copepods, while there are still gaps in the information about the small rotifers. Extensive analyses of invertebrate macrofauna on the population ecology level give a valuable basis for the estimation of energy flow and material circulation in the boddens and of the qualitative and quantitative nutritional potential of the fish. At the beginning of the 1980s, multidisciplinary mesocosm experiments substantiated the dominant role of microbial food webs in the flow of energy and circulation of matter in the Darss-Zingst Bodden chain. Restoration goals for the Darss-Zingst Bodden include an external load reduction of 65% for the 1986-1990 period. Future research will focus on the establishment of a standard for coastal water assessment, protection of reproduction of the spring herring, and trouble-free operation of the nuclear powerplant at Lubmin. (Geiger-PTT)
W91-04750

DESORPTION KINETICS AND MOBILITY OF SOME RADIONUCLIDES IN SEDIMENTS.
Kyoto Univ., Osaka (Japan). Research Reactor Inst.
For primary bibliographic entry see Field 5B.
W91-04776

STABILITY ANALYSIS OF A TWO-INLET BAY SYSTEM.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Applied Marine Physics.
J. van de Kreeke.
Coastal Engineering COENDE, Vol. 14, No. 6, p 481-497, December 1990. 12 fig, 2 tab, 13 ref. NOAA grant NA 86AA-D-SG068.

Descriptors: *Bays, *Florida, *Model studies, *Tidal hydraulics, *Tides, Diurnal variation, Shear stress, Tidal currents, Velocity.

The stability analysis for a double-inlet bay system was applied to an inlet system resembling Big Marco Pass and Capri Pass on the lower west coast of Florida. Since the opening of Capri Pass in 1967, the length of Big Marco Pass has increased from 2000 m in 1967 to 3000 m in 1988 and the cross-sectional area has decreased from 1200 sq m in 1967 to 1000 sq m in 1988. Since 1967, the cross-sectional area of Capri Pass has steadily increased and in 1988 was 700 sq m. Tides off the inlets are of the mixed type with a diurnal range of 1 m. The gross littoral transport rate in the vicinity of the inlets is estimated at 150,000 cu m/y. For each inlet the maximum tidal velocities were calculated as a function of the gorge cross-sectional areas using a

lumped-parameter model to describe the hydrodynamics of the flow. In the model it was assumed that the bay level fluctuates uniformly and the bay surface area remains constant. The velocities were used to calculate the tidal maximum of the bottom shear stress in each inlet as a function of the cross-sectional areas of the two inlets (=closure surface). Values of the equilibrium shear stress were derived from an empirical relationship between cross-sectional area and tidal prism for stable inlets along the west coast of Florida. Closure surfaces and equilibrium stress values were calculated for values of friction factors ranging from F=.004 to F=.006. Using the closure surfaces and equilibrium stress values, the equilibrium flow curve for each inlet was determined. The equilibrium flow curve represents the locus of the combination of cross-sectional areas for which the actual bottom shear stress in the inlet equals the equilibrium shear stress. Based on the equilibrium flow curves and the known values of the cross-sectional areas of the two inlets in 1988, it is expected that, ultimately, Big Marco Pass will close and Capri Pass will remain as the sole inlet with a cross-sectional area of 1250 sq m and a maximum tidal velocity pertaining to a diurnal tide of 0.85 m/s. (Author's abstract)
W91-04836

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DYNAMICALLY FORMED HYDROUS ZIRCONIUM(IV) OXIDE-POLYELECTROLYTE MEMBRANES: IX. POLY(ACRYLIC ACID-CO-HYDROXYETHYL ACRYLATE) AND POLY(ACRYLIC ACID CO-HYDROXYETHYL METHACRYLATE) MEMBRANES.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
A. J. van Reenen, S. Gerber, and R. D. Sanderson.
Water SA WASADV, Vol. 16, No. 4, p 219-226, October 1990. 13 fig, 6 tab, 11 ref.

Descriptors: *Desalination, *Membrane processes, *Membranes, *Polymers, *Salt rejection, *Semipermeable membranes, Acrylic acid, Dynamic membranes, Hydrogen ion concentration, Membrane synthesis, Polyelectrolytes, Zirconium oxide.

Dynamic membranes for desalination were prepared using polyelectrolytes other than poly(acrylic acid). A series of two different copolymers were synthesized: (1) poly (acrylic acid-co-hydroxyethyl acrylate)(C1 to C3) and (2) poly(acrylic acid-co-hydroxyethyl methacrylate)(C4 to C6). Hydrous zirconium(IV) oxide-C1 to C6 membranes were dynamically formed. The acrylic acid content was varied between 20 and 80% in both copolymer ranges. With the exception of the Zr-C6 membrane, decreasing acrylic acid concentration decreased the influence of feed salt concentration on salt rejection. Increasing the pH of the feed solution from 5 to 9 led to increased salt rejection due to the ion exchange properties of the membrane and a decrease in membrane flux. The membranes became less sensitive to an increase in pH as the acrylic acid content increased. It is concluded that although the presence of comonomers with acrylic acid in the copolymers does not lead to increased salt rejection, the presence of the comonomers makes the membranes less sensitive to variations in the feed salt concentration. It is suggested that the use of materials having different molecular masses may increase membrane performance. (MacKeen-PTT)
W91-04313

MINIMISING LIQUID DISCHARGE FROM LARGE POWER PLANTS.
Eskom, Johannesburg (South Africa). Chemical Engineering and Chemistry Div.
For primary bibliographic entry see Field 5D.
W91-04321

FROM BRINE TO SUBLIME.
Camp, Dresser and McKee, Inc., Ontario, CA.
D. Smith.
Public Works PUWOAH, Vol. 121, No. 13, p 35-37, December 1990.

Descriptors: *Brines, *California, *Desalination, *Groundwater potential, *Reclaimed water, Arlington Basin, Brackish water, Dissolved solids, Groundwater movement, Nitrates.

The recently completed Arlington Basin desalination project, located in Riverside, California, treats six mgd of brackish groundwater and turns it into a valuable resource for direct use or local groundwater replenishment. Brought on-line in June 1990, the facility consists of five 200-ft deep, alluvial groundwater extraction wells that will produce the seven mgd of raw water needed to produce six mgd of treated water. The treatment process reduces total dissolved solids in the groundwater from levels as high as 1,000 to 1,100 ppm to about 500 ppm and also reduces nitrates from levels of about 90 ppm to 42 ppm. Based on computer simulations of well water level drawdown and subbasin groundwater movement, the wells were sited to optimize the movement of groundwater within the subbasin. This movement will promote the gradual improvement in subbasin water quality by inducing a natural inflow of better quality water form the periphery of the subbasin. This gradual process will take 20 to 40 years before the groundwater will improve to the point where it can potentially be used without treatment for domestic purposes. (White-Reimer-PTT)
W91-04847

AROMATIC POLYAMIDE HYDRAZIDE MEMBRANES FOR REVERSE OSMOSIS SEPARATIONS.
Bhabha Atomic Research Centre, Bombay (India). Desalination Div.
R. C. Bindal, V. Ramachandhran, B. M. Misra, and M. P. S. Ramani.
Separation Science and Technology SSTEDS, Vol. 25, No. 9/10, p 1053-1062, July/August 1990. 2 fig, 5 tab, 19 ref.

Descriptors: *Desalination, *Membranes, *Polymers, *Reverse osmosis, *Wastewater treatment, Ammonium, Nitrates, Performance evaluation, Permselective membranes, Radioactive wastes.

Wholly aromatic polyamide hydrazide (PAH) polymers were synthesized by low temperature polycondensation from freshly prepared m-amino benzhydrazide, p-amino benzhydrazide, isophthaloyl chloride, and terephthaloyl chlorides in dimethyl acetamide solvent. A series of film-forming polymers prepared by altering the molar ratios of the reacting monomers was characterized in terms of % moisture regain, and x-rays. Asymmetric membranes prepared from selected polymer samples were tested in reverse osmosis (RO) test cells, and the pure water permeability and the membrane constant were determined. Membranes with a 60/40 molar ratio of meta-/para-substituted monomers appear to give optimum performance with feed concentrations in the range encountered in sea water desalination, and solute separations close to 98% could be achieved. Whereas this may not be sufficient to obtain potable water from sea water, it may meet situations where higher product salinity with a lower recovery can be practiced. However, further work is necessary to obtain a satisfactory sea water RO membrane. Another potential area for the application of these membranes is in low level radioactive waste treatment. Even with the solute rejections achieved in the above experiments, these membranes have the potential to give higher decontamination factors (DF) than cellulose acetate membranes and even in other methods of decontamination, except for evaporation (which in any case is energy intensive). These membranes also appear to be potential candidates for the treatment of effluents containing ammonium and nitrates. Further work with modified polymers appears to give promise of better solute rejection and hence suitability for sea water desalination. (Lantz-PTT)
W91-04906

3B. Water Yield Improvement

WATER CONSERVATION FOR DROUGHT MANAGEMENT.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 499-505.

Descriptors: *Drought effects, *Water conservation, *Water resources management, *Water use data, Cloud seeding, Drought, Evapotranspiration, Groundwater recharge, Water reuse, Water transfer.

Water conservation can be achieved by reducing evaporation, transpiration, and quality degradation; and by cloud seeding, enhancing groundwater recharge, and treating or reusing sewage or other contaminated water. Arid and semiarid regions commonly have widely fluctuating seasonal or annual rainfall. In these water-short areas, there usually is no single solution for solving problems of inadequate water supplies. Rather, a broad approach is needed, saving water, using water more efficiently, and reusing water wherever possible. Only then can limited water supplies be effectively managed. (See also W91-04161) (Lantz-PTT)
W91-04214

PHOENIX WATER RESOURCE PLAN--1987.
Phoenix City Water and Wastewater Dept., AZ.
For primary bibliographic entry see Field 6A.
W91-04245

EVAPORATION REDUCTION IN STOCK TANKS FOR INCREASING WATER SUPPLIES.
Central Arid Zone Research Inst., Jodhpur (India).
M. A. Khan, and V. C. Issac.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 21-29, November 1990. 1 fig, 2 tab, 14 ref.

Descriptors: *Arid lands, *Evaporation control, *India, *Water conservation, *Water tanks, Cost analysis, Livestock, Potable water, Rajasthan, Surface films, Tank covers, Water supply development.

Evaporation from a free water surface is, in arid regions, a major constraint in developing local water supplies for human and livestock consumption. Conserving stored rainwater in existing storage facilities by reducing evaporation losses is the most economical means for providing usable water supplies for a longer period. Studies were conducted in Rajasthan, India, to evaluate the performance of shading and floating materials in reducing evaporation from a free water surface. White polyethene sheet used for shading the water surface reduced evaporation by 91% and cost Rs. 2.54 (US$ 0.15) per 1000 L. Floating materials evaluated were polyethene sheet, foam rubber sheet, polystyrene sheet, bamboo, and Sacchrum munja. Evaporation reduction for a 19-month test period ranged from 37% for S. munja to 82% for polystyrene sheet. Foam rubber sheet, polyethene sheet, and bamboo reduced evaporation by 74, 66, and 53%, respectively. The polystyrene sheet and polyethene sheet covers were the most economical, saving water at a cost of Rs. 3.07 (US$ 0.19) and Rs. 4.44 (US$ 0.27) per 1000 L, respectively. (Author's abstract)
W91-04387

ESTIMATES OF CONSUMPTIVE USE AND GROUND-WATER RETURN FLOW AND THE EFFECT OF RISING AND SUSTAINED HIGH RIVER STAGE ON THE METHOD OF ESTIMATION IN CIBOLA VALLEY, ARIZONA AND CALIFORNIA, 1983 AND 1984.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 4B.
W91-04465

3C. Use Of Water Of Impaired Quality

DEEP WASTEWATER RESERVOIRS IN ISRAEL: EMPIRICAL DATA FOR MONITORING AND CONTROL.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
For primary bibliographic entry see Field 5E.
W91-04036

EFFECTS OF SALINITY ON RIVER, STREAM AND WETLAND ECOSYSTEMS IN VICTORIA, AUSTRALIA.
Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.
For primary bibliographic entry see Field 5C.
W91-04040

COSTS OF WASTEWATER USE IN THE TUCSON BASIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 6C.
W91-04195

GROWTH RESPONSES, ION RELATIONS, AND OSMOTIC ADAPTATIONS OF ELEVEN C4 TURFGRASSES TO SALINITY.
Hawaii Univ., Honolulu. Dept. of Horticulture.
K. B. Marcum, and C. L. Murdoch.
Agronomy Journal AGJOAT, Vol. 82, No. 5, p 892-896, September/October 1990. 9 fig, 1 tab, 23 ref.

Descriptors: *Agronomy, *Plant growth, *Plant physiology, *Saline soils, *Salt tolerance, *Soil-water-plant relationships, *Turf grasses, Bermudagrass, Hawaii, Ions, Leaves, Osmoregulation, Roots, Saline water, Sodium chloride.

Shortages of fresh water, coupled with soil salinization in many areas have resulted an increased need for salt tolerant turf grasses. A study was conducted to compare growth and physiological responses of eleven C4 turf grasses (grasses which utilize the C-4 carboxylic acid pathway in photosynthesis) to salinity. Grasses were grown in solution culture in a glasshouse, with sodium chloride (NaCl) added to achieve salinities of 0.7, 10, 20, and 30 dS/m (0, 99, 198, and 298 mM NaCl). Grasses were ranked for salinity tolerance according to their relative top growth reductions with increasing salinity. Tolerant grasses included a Hawaii selection of seashore paspalum, two St. Augustine grasses, and manilagrass. Bermudagrasses tested were generally less tolerant to salinity. Shoot and root Na and Cl concentrations reached very high levels in St. Augustine grasses, and were relatively high in seashore paspalum and Japanese lawngrass. In contrast, manilagrass and bermudagrasses maintained low levels of Na and Cl under high salinity which is indicative of ion regulation, due in part to efficient leaf salt glands. Seashore paspalum maintained higher shoot and root potassium (K) concentrations under high salinity than did other grasses. All grasses adjusted osmotically under increasing salinity, although St. Augustine grasses and seashore paspalum accumulated Na and Cl in the shoots to relatively high levels, they maintained much higher tissue water levels than did other grasses, resulting in intermediate sap osmolalities. (Author's abstract)
W91-04508

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: I. SOIL AND LEACHATE WATER QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. R. Hayes, C. F. Mancino, and I. L. Pepper.
Agronomy Journal AGJOAT, Vol. 82, No. 5, p 939-943, September/October 1990. 2 fig, 5 tab, 26 ref.

Descriptors: *Impaired water use, *Secondary wastewater, *Turf grasses, *Wastewater irrigation, *Water pollution effects, *Water quality, *Water reuse, Conductivity, Drinking water, Irrigation water, Leachates, Potable water, Soil contamination, Water resources management.

In arid climates water is a limited resource, and turf grass is often irrigated with municipal effluent. However, the effects on soil and leachate water quality of continuous turf grass irrigation with sewage effluent need to be evaluated. A field experiment was performed to evaluate the effect of secondary treated municipal effluent irrigation on soil and leachate properties under a turf groundcover during the first 16 months of irrigation. Research plots were irrigated identically with either effluent or potable water using a leaching fraction of approximately 20%. Effluent irrigation resulted in significant changes in soil properties after a relatively short period of time. After 16 months of use, when compared with potable irrigation, effluent was found to increase electrical conductivity (EC) by 0.5 dS/m, NO3-N by 7.8 mg/kg, P by 31.7 mg/kg, K by 134 mg/kg, Na by 6.0 mmol/L, and the exchangeable sodium percentage (ESP) by 6.8. Soil Ca + Mg concentrations were greater under effluent irrigation by 0.5 mmol/L but decreased during the study period. Soil pH was not significantly different from potable irrigation. Leachates collected at 0.61-m depth indicated that effluent soil leachates were higher than potable leachates in EC (by 0.2 dS/m) and Na content (by 0.8 mmol/L). The increase did not exceed current recommended limits for drinking water quality. (See also W91-04510) (Author's abstract)
W91-04509

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: II. TURF QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. R. Hayes, C. F. Mancino, W. Y. Forden, D. M. Kopec, and I. L. Pepper.
Agronomy Journal AGJOAT, Vol. 82, No. 5, p 943-946, September/October 1990. 1 fig, 2 tab, 15 ref.

Descriptors: *Impaired water use, *Irrigation practices, *Secondary wastewater, *Turf grasses, *Wastewater irrigation, *Water pollution effects, *Water quality, *Water reuse, Bermudagrass, Fertilization, Golf courses, Irrigation water, Leaching, Nutrients, Perennial ryegrass, Potable water, Seeds, Soil contamination, Water resources management.

Due to limited water resources, golf course irrigation with municipal sewage effluent is a common practice, and, in some areas of the U.S. Desert Southwest, mandatory. However, effluent irrigation changes soil properties and therefore different management practices are needed for good quality turf grass. A field experiment was performed to evaluate the continuous use of secondary treated municipal sewage effluent on turf grass quality over a 64-week period. In April 1987, common bermudagrass was seeded to a Sonoita gravelly sandy loam and maintained under fairway conditions. In October of that year, perennial ryegrass was overseeded to maintain an actively growing turf. Plots were irrigated identically with either effluent or potable water. Effluent irrigation led to significantly lower seed emergence but improved seed establishment. Turf quality was assessed under each irrigation with four N fertilization rates of 0, 16.1, 32.3, and 48.4 kg N/ha/4-wks. Established effluent irrigated turf did not show signs of osmotic stress with the leaching fraction employed. Effluent provided significant amounts of nutrients at high application rates. No single fertilization rate or irrigation regime consistently produced a superior turf quality over the course of the study. Effluent irrigated turf showed signs of overfertilization, greater heat stress, and chlorosis of overseeded ryegrass stands during the summer months on plots receiving N fertilizer amendments. Municipal effluent did produce a high quality turf, but the greater soluble salt and nutrient content of the water necessitate special management strategies. (See also W91-04509) (Author's abstract)
W91-04510

SAND CULTURE OF VEGETABLES USING RECIRCULATED AQUACULTURAL EFFLUENTS.
North Carolina State Univ., Raleigh. Dept. of Horticultural Science.
For primary bibliographic entry see Field 3F.
W91-04542

SALT OF THE EARTH: SECONDARY SOIL SALINIZATION IN THE AUSTRALIAN WHEAT BELT.
Western Australia Univ., Nedlands. Dept. of Geography.
A. J. Conacher.
Environment ENVTAR, Vol. 32, No. 6, p 4-9,40-42, July/August 1990. 2 fig, 27 ref.

Descriptors: *Australia, *Cropland, *Saline soils, *Surface-groundwater relations, *Water table rise, *Waterlogging, Cereal crops, Deforestation, Ecosystems, Environmental policy, Farming, Governmental interrelations, Grazing, Hydrologic cycle, Land development, Land management, Land use, Overland flow, Research priorities, Saline groundwater, Saline water systems, Soil conservation, Vegetation.

Thirty-nine percent of the 13,400 farmers throughout southwestern Australia have reported that their land suffers from secondary soil salinization. Virtually all of this salinity is found in the rainfed wheatbelt of the state of Western Australia, where some 13 million ha of indigenous woodland have been cleared to establish a mixed agricultural economy of cereal crops and sheepfarming. In the past, it was determined that soil salinization is due to a rising groundwater table caused by land clearing, and by waterlogging caused by throughflow and overland flow. However, disagreement over the causal mechanisms has given rise to disagreement over the necessary remedial measures. In 1978, a group of farmers formed the Whittington Interceptor Salt Affected Land Treatment Society (WISALTS) to promote the use of interception methods of salinity control, which is discouraged by the Department of Agriculture because of its economic inefficiency. Recent research on the processes responsible for secondary salinization reveals that throughflow is the dominant mechanism transporting water and salts to low-lying areas (salt scalds). One of the more important realizations regarding secondary soil salinization is that this problem is only one manifestation of a severely disrupted ecosystem. Replacement of the natural vegetation with crops and pasture disturbs the terrestrial portion of the hydrologic cycle and the pattern of groundwater movements in particular. The Land Management Society (LMS) and Soil Conservation Districts were formed in the early 1980s to approach these problems. However, Western Australians continue to suffer from the rather crucial division of responsibilities between government agencies. (Fish-PTT)
W91-04557

GROWTH RESPONSE OF PHASEOLUS VULGARIS TO VARYING SALINITY REGIMES.
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.
K. Wignarajah.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 2, p 141-147, April 1990. 5 fig, 2 tab, 24 ref.

Descriptors: *Beans, *Plant growth, *Saline soils, *Salt stress, *Salt tolerance, *Soil-water-plant relationships, Irrigation effects, Leaves, Plant physiology, Vegetable crops, Water pollution effects.

It is estimated that 40,000,000 ha of the world's 220,000,000 ha irrigated soils are affected by salinity. High concentrations of sodium chloride result in marked changes of the growth pattern of plants, usually resulting in suppression of growth in mesophytic and crop plants. Kidney beans (Phaseolus vulgaris) were tested in four different levels of NaCl solutions (0, 48, 72, and 96 mM) to determine the effects of salinity on growth. It was found that the beans tolerate low (48 mM NaCl), but not higher levels (72 and 96 mM NaCl) of salinity

stress. At the low salinity stress, there is an initial delay in development (morphogenetic shift) of the leaves. Salinity affects shoot growth more than root growth. Osmotic adjustment to salt stress results in an increased water content in the leaves. These results suggest that two major physiological traits enable the plants to tolerate salinity: (1) compensatory growth following adjustment to salinity, and (2) ability to increase both leaf area ratio and net assimilation rate to achieve this increased growth. These characteristics are important physiological traits which can be used in screening for potential salt-tolerant lines of beans and other crop plants. (Author's abstract)
W91-04559

LEACHING OF A HIGHLY SALINE-SODIC SOIL IN SOUTHERN ALBERTA: A LABORATORY STUDY.
Alberta Agriculture, Lethbridge. Land Evaluation and Reclamation Branch.
D. B. Harker, and D. E. Mikalson.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 509-514, August, 1990. 3 fig, 1 tab, 17 ref.

Descriptors: *Alberta, *Irrigation effects, *Leaching, *Saline soils, *Soil reclamation, Hydraulic conductivity, Infiltration, Water table, Waterlogging.

It has been estimated that from 10 to 30% of irrigated lands in southern Alberta are affected by salinity and water logging problems. Reclamation of these soils may be accomplished by controlling the excess water source and/or by providing adequate drainage to lower the water table followed by leaching of soil salts as water from irrigation and precipitation drain through the soil. The amount of leaching water and the amount of time that will be required to reclaim a soil will depend on the depth of soil to be reclaimed, the initial salinity level, the type of salts present and soil characteristics such as texture, structure, infiltration and permeability. Moderate to highly saline-sodic soil cores extracted from a Brown Solodized Solonetzic soil were leached in the laboratory using good-quality irrigation water to determine relative salt removal with time. Leaching curves comparing the relative concentration of salts against the relative depth of leaching water applied were similar over a wide range of salinities and hydraulic conductivities. The time required to transmit an equivalent depth of water through the soil core and achieve a salinity reduction of about 75% ranged from less than 2 d to an estimated 15 mo. The primary limitation to reclamation in these soils was the low hydraulic conductivity rather than the initial salt content or depth of leaching water required. (White-Reimer-PTT)
W91-04586

REALIZING THE BENEFITS OF WATER REUSE IN DEVELOPING COUNTRIES.
Camp, Dresser and McKee, Inc., Raleigh, NC.
D. A. Okun.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 78-82, November 1990. 1 fig, 4 tab, 4 ref.

Descriptors: *Developing countries, *Reclaimed water, *Water demand, *Water reuse, Case studies, Economic aspects, Industrial water, Planning, Urban areas.

The water supply demands of growing urban regions will outstrip available water resources especially in developing areas such as Asia, Africa, and Latin America. In industrialized countries, the practice of water reclamation for nonpotable purposes has been increasingly relied on to provide a new source of water to meet urban needs. Since the costs of developing new water resources for urban areas are high, water reclamation for reuse may well be economically attractive. Direct potable reuse should not be considered because it is not yet proven or acceptable, nor is it likely to be in the current planning horizon. For a water-reclamation program to be instituted, urban areas must be sewered. The typical approach involves the reclamation of wastewater for a single large user. Power plants with evaporative cooling towers are large users of reclaimed water. The most practical approach in developing countries is to coordinate wastewater treatment projects with water reuse programs. Planners can lower costs by considering water reclamation in initial planning stages and by situating plants in appropriate areas. Where the impetus for reuse comes from water resource needs, the plants should be located upstream on the sewerage system, nearer the potential markets. This has a further advantage in that reclaimed water that is not sold can help sustain the flow in urban streams that would otherwise be dry. Examples of potential and ongoing water reuse programs in Brazil, China, the United States, and Africa illustrate the benefits of water reclamation. Because the value of water in urban and industrial uses is much greater than in agriculture, the cost-recovery potential to municipalities providing the reclamation service gives better assurance that the system will be properly managed than if the reclaimed water were used solely for agriculture. (White-Reimer-PTT)
W91-04604

U.S. WATER REUSE: CURRENT STATUS AND FUTURE TRENDS.
CH2M/Hill, Denver, CO.
K. J. Miller.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 83-89, November 1990. 5 tab.

Descriptors: *Reclaimed water, *United States, *Water demand, *Water reuse, Agriculture, Case studies, Florida, Industrial water, Irrigation, Municipal water, Potable water, Public health, Tampa.

The history of water reuse in the U.S. and examples of various planned and unplanned, direct and indirect water reuse throughout the country are presented. Benefits attributable to wastewater reclamation generally fall into two categories: supplementing available resources and pollution abatement. Water reclamation and reuse supplement or enlarge what may otherwise be a fixed quantity of water available for use in a given area. In the U.S. today, water reuse practices can be broken down into the following categories: indirect potable reuse, agricultural reuse, urban landscape irrigation, industrial reuse, groundwater recharge, and potable reuse demonstration. In Tampa, Florida a research program has been designed to determine the health risks associated with reuse of a pilot plant water as a component blended into a raw potable water supply. The final product will be placed into the Tampa bypass canal to recharge an adjacent aquifer and then flow into the Hillsboro River upstream of a raw water intake. To date, water quality parameters of the treated water exceed those of the river water. Water reuse in both the U.S. and worldwide will inevitably increase as existing water supplies are incapable of meeting future demand brought about by increasing world populations and industrialization. The municipal, industrial, and agricultural demands will have to be met; probably by expanded water reuse programs. (White-Reimer-PTT)
W91-04605

SOIL SALINITY: IRRIGATION PRACTICES AND EFFECTS ON CROPS AND GROUND WATER (JAN 77--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-867097. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 129p.

Descriptors: *Bibliographies, *Groundwater quality, *Impaired water use, *Irrigation practices, *Saline water, *Salinity, Beans, Brackish water, Citrus crops, Grain crops, Saline groundwater, Saline soils, Salt tolerance.

This bibliography contains citations concerning the effects on crops and groundwater from saline irrigation waters. The salt tolerance of crops, including beans, grains, and citrus fruits, are examined. Soil and groundwater salinity, and surface water salinity are discussed, and the sources of brackish waters are considered. (This updated bibliography contains 271 citations, 83 of which are new entries to the previous edition.) (Author's abstract)
W91-04649

FROM BRINE TO SUBLIME.
Camp, Dresser and McKee, Inc., Ontario, CA.
For primary bibliographic entry see Field 3A.
W91-04847

3D. Conservation In Domestic and Municipal Use

REDUCING WATER DEMAND DURING DROUGHT YEARS.
East Bay Municipal Utility District, Oakland, CA.
J. B. Gilbert, W. J. Bishop, and J. A. Weber.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 34-39, May 1990. 4 fig, 3 tab, 2 ref.

Descriptors: *Drought, *Water conservation, *Water costs, *Water demand, *Water use, Irrigation, Metropolitan water management, Public relations, Regulations, Water policy.

Responding to second and third consecutive drought years, Oakland, CA's East Bay Municipal Utility District implemented drought programs with mandatory conservation goals individually specified for 5 customer groups--single-family residential, multifamily residential, industrial commercial, and irrigation. A strict drought ordinance was passed which regulates vehicle washing and expansion of existing lawn areas, specifies that new service connections be drought-compliant, and does not allow annexation of territory outside the district's ultimate service boundary. A 'wastewatcher patrol' will be established to identify violations and flow-restricting devices will be installed in the event of prolonged noncompliance. To provide a financial incentive to all customers, an inclining-block rate structure was established that progressively increases the cost of water use above a base allotment. An extensive public relations campaign was conducted using radio spots, billboards, newspaper ads, and shopping-mall displays. Conservation education programs in local schools were expanded by providing additional publications, classroom presentations, and take-home materials. A sympathetic press corps also provided daily reminders of the shortage conditions. These measures collectively achieved reductions in consumption during the summers of 1988 and 1989 of 30 and 27 percent, respectively, compared with the 25 and 15 percent conservation levels that had been established for these periods. (Doyle-PTT)
W91-03971

WATER-USE EFFICIENCY STANDARDS FOR PLUMBING FIXTURES: BENEFITS OF NATIONAL LEGISLATION.
Brown and Caldwell, Boston, MA.
A. Vickers.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 51-54, May 1990. 5 tab, 14 ref.

Descriptors: *Domestic water, *Legislation, *Standards, *Water conservation, *Water use efficiency, National Plumbing Products Efficiency Act, Plumbing, Regulations, Water management, Water use.

The proposed National Plumbing Products Efficiency Act, also known as the Atkins-Fowler bill, would establish nationwide water-use standards for plumbing fixtures and appliances, labeling requirements, and a national water use data base. Reduction of water use by efficient low volume showerheads, faucets, flush toilets,and urinals is intended to reduce the costs of developing new sources of raw water, and treatment plant construction or enlargement, as well as protect groundwater wells from contamination. Potential benefits of this legislation include the creation of a national conservation policy and the institutional framework neces-

sary to ensure adequate future supplies of water. (Doyle-PTT)
W91-03972

CONSERVATION IN ARABIAN GULF COUNTRIES.
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
For primary bibliographic entry see Field 6D.
W91-03973

OPERATING THE SEATTLE WATER SYSTEM DURING THE 1987 DROUGHT.
Washington Univ., Seattle. Dept. of Civil Engineering.
D. P. Lettenmaier, E. F. Wood, and D. B. Parkinson.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 55-60, May 1990. 6 fig, 1 tab, 10 ref.

Descriptors: *Drought, *Metropolitan water management, *Model studies, *Seattle, *Water shortage, Hydrologic models, Seattle Water Department, Snowmelt, Streamflow forecasting, Water resources management.

The Seattle Water Department receives its supply from reservoirs on the Cedar and Tolt rivers, which drain the western slopes of the Cascade Mountains. Most droughts in the Northwest are the result of deficient winter snowfall. The 1987 drought was unusual in that the previous winter's precipitation was close to normal, but the summer dry period extended into the late fall, causing a severe water shortage. For this reason, a medium-term forecast model was developed to assist in the evaluation of the management alternatives during a critical 16-week period from late summer to late fall 1987. A key feature of the model was that it predicted a best forecast at each of four inflow points, as well as the probability distribution of the forecasts. (Author's abstract)
W91-03974

WATER USE IN KENTUCKY, 1985, WITH EMPHASIS ON THE KENTUCKY RIVER BASIN.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04171

COMMODITY PRICES, DEMAND CHARGES, IMPACT FEES AND WATER SERVICES.
Georgia Univ., Athens. Inst. of Natural Resources.
For primary bibliographic entry see Field 6C.
W91-04177

PRICE AND INCOME ELASTICITIES IN THE ANALYSIS OF WATER DEMANDS FOR THE CITY OF HAYS, KANSAS.
Missouri Univ.-Rolla. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W91-04178

MEASURING THE PUBLIC'S PERCEPTION OF WATER RESOURCES USING THE CONTINGENT VALUATION METHOD.
New Hampshire Dept. of Resources and Economic Development, Concord.
For primary bibliographic entry see Field 6A.
W91-04179

PRACTICAL APPLICATION OF THE WATER BALANCE APPROACH FOR MEASURING CANAL CONVEYANCE LOSSES.
Rice (Leonard) Consulting Water Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 3F.
W91-04226

FORECASTING MUNICIPAL WATER DEMAND AND CONSERVATION EVALUATION: THE IWR-MAIN SYSTEM 5.1.
Planning and Management Consultants Ltd., Carbondale, IL.
For primary bibliographic entry see Field 6D.
W91-04242

ROLE OF THE FIRE MARSHAL'S OFFICE.
For primary bibliographic entry see Field 6D.
W91-04843

3E. Conservation In Industry

TREATED MUNICIPAL SEWAGE EFFLUENT AS A SOURCE OF POWER PLANT COOLING TOWER MAKEUP WATER.
Water Reclamation Facility, Phoenix, AZ.
For primary bibliographic entry see Field 5D.
W91-04221

CONSERVING WATER RESOURCES THROUGH INTEGRATED POWERPLANT WATER MANAGEMENT.
San Juan Generating Station, Waterflow, NM.
D. H. Paul.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 581-584, 3 ref.

Descriptors: *Industrial water, *Powerplants, *Water conservation, *Water resources management, *Water use data, Economic aspects, Education, Personnel, Policy making, Training, Wastewater treatment, Wastewater utilization, Water reuse.

Conserving water resources requires an integrated approach. Equipment and process may be modified or optimized to achieve water conservation. In many cases, more importantly, personnel may be trained and optimized to achieve the greatest water resources management. At the San Juan Generating Station, an integrated approach to water resources management has been implemented since the early 1980s. The water resource management approach includes three major areas to be integrated: equipment, process, and people. The equipment was designed and constructed to meet the existing problem of achieving and maintaining zero discharge. The equipment is optimized by extensive, 4-year, maintenance training programs. The water treatment and wastewater recovery processes continue to be optimized to meet current business and economic situations. These optimizations are made possible and are many times initiated by the highly trained operating personnel. The most important element in water resources management is people. Optimizing people through training and supportive management is a challenge for all businesses. At the San Juan Generating Station, the challenge continues to be met by ongoing annual training in the areas of: (1) technical training; (2) nontechnical training (e.g., cost reduction techniques); and (3) supportive-management-style training. The results of this integrated approach include operation and maintenance savings of about $1 million per year. Additionally, wastewater processing quantity and costs continue to decrease. (See also W91-04161) (Lantz-PTT)
W91-04222

PLANNING FOR USE OF UNCONVENTIONAL WATER SOURCES.
Electric Power Research Inst., Palo Alto, CA. Planning and Evaluation Div.
E. G. Altouney, and R. F. Ehrhardt.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 585-589, 1 tab.

Descriptors: *Industrial water, *Planning, *Water conservation, *Water resources management, *Water supply, *Water use data, Cooling water, Electric powerplants, Management planning, Water reuse, Water use.

Alternatives to readily accessible freshwater sources are an important priority for high volume water users such as steam electric power plants. This need has been faced by electric utilities in naturally arid areas for at least two decades. Even in naturally water rich areas, unconventional sources can be expected to become more important as competition increases for available freshwater supplies. Unconventional sources of water supply can enable facility siting and operation which might not otherwise be possible if only conventional sources were considered. One planning method requires follows the following 8-step procedure: (1) Specify site location and cooling system characteristics; (2) Specify candidate cooling water sources; (3) Determine water flow and consumption requirements of the cooling system; (4) Determine physical accessibility; (5) Determine legal availability; (6) Determine environmental acceptability; (7) Determine technical performance acceptability; and (8) Calculate grant total and compare alternative cooling water sources. (See also W91-04161) (Lantz-PTT)
W91-04223

WATER RESOURCES AND THE ELECTRIC POWER INDUSTRY: AN AUSTRALIAN PERSPECTIVE.
J. K. Laughlin, D. V. McCrohan, and R. E. Black.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 591-599, 5 tab, 5 ref.

Descriptors: *Alternative water use, *Australia, *Economic aspects, *Electric powerplants, *Industrial water, *Water resources management, *Water use data, Case studies, Lochiel Power Station, Wastewater utilization, Water conservation, Water reuse.

Australia is the dryest continent on earth. The relationships between water resources and powerplants in continental Australia have much in common with those found in the southwestern United States. Similar to the U.S., most of Australia's vast coal resources are located inland in areas where high quality water is limited. While new coastal powerplant sites are still available in some areas, Australia's electric generating authorities and water resource planning agencies are now facing the challenges of allocation and pricing of high quality wastewater supplies versus the development and treatment of low quality water supplies for inland powerplant locations. A study of the Lochiel Power Station was made to determine the economics of alternative water supply sources. Results suggest that: (1) a mine water/groundwater supply is the most economic source; (2) dry ash handling is less expensive; (3) Murray River Water, although the most suitable for cooling make-up, is too expensive; (4) cooling towers were less expensive than a closed cycle cooling lake because of lower make-up requirements; (5) potential degradation of groundwater quality is likely, and the volume of mine water is uncertain. Hence, future powerplants at inland locations will continue to face difficulties in identifying suitable water supplies at a reasonable cost. (See also W91-04161) (Lantz-PTT)
W91-04224

INDUSTRIAL WATER USE AND STRUCTURAL CHANGE.
Inland Waters Directorate, Ottawa (Ontario). Water Planning and Management Branch.
D. M. Tate.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 601-609, 2 tab, 10 ref.

Descriptors: *Industrial water, *Water use, *Water use data, Case studies, Economic aspects, Social aspects, Technology, Water resources development.

Structural and technological changes, which have occurred continuously throughout history, are largely responsible for the economic advancement of societies, and the remnants of past economic structures and past technologies may be seen into the present day. Since structural and technological

change is such a fundamental factor in economic development, it has important effects on resource use. Past studies of the interfaces between structural and technological change and water resource use have focused at the micro or local level, whereby one, or a small number of activities (or industries, in this case) are studies to determine water use implications of varying technologies. Factors examined include the level of economic demand, the types of production technology in use and the various water use patterns employed in different industries. The case studies conducted to date indicate that plant production technology tends to decrease industrial water use over time, while economic activity tends to increase it. The actual water use patterns and changes are therefore fairly stable, and are variable, but relatively minor, in their impacts on changing water use volumes. (See also W91-04161) (Lantz-PTT)
W91-04225

RESISTANCE TO MICROBIOLOGICAL DETERIORATION OF GEOTEXTILES USED AROUND AGRICULTURAL DRAINS: A REVIEW.
Alberta Univ., Edmonton. Dept. of Clothing and Textiles.
For primary bibliographic entry see Field 8G.
W91-04545

STAR FIRE MINE RECLAMATION EXPERIENCE.
Kentucky Univ., Lexington. Dept. of Horticulture and Landscape Architecture.
For primary bibliographic entry see Field 4C.
W91-04562

FLORIDA'S REUSE PROGRAM PAVES THE WAY.
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5D.
W91-04822

3F. Conservation In Agriculture

CONSERVATION IN ARABIAN GULF COUNTRIES.
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
For primary bibliographic entry see Field 6D.
W91-03973

NITRATE-N IN THE SOIL PROFILE AND TILE DRAINAGE WATER AS INFLUENCED BY TILLAGE.
Minnesota Univ.-Waseca. Southern Experiment Station.
For primary bibliographic entry see Field 5B.
W91-04004

CASE STUDY IN SURVEY DEVELOPMENT: 1988 FARM AND RANCH IRRIGATION SURVEY.
Bureau of the Census, Washington, DC.
For primary bibliographic entry see Field 6D.
W91-04164

EFFECTS OF A PUMPING TAX ON GROUND WATER DEMAND BY IRRIGATORS.
Economic Research Service, Washington, DC. Soil and Water Branch.
For primary bibliographic entry see Field 6C.
W91-04180

EFFECTS OF REGIONAL GROUND-WATER LEVEL DECLINES ON STREAMFLOW IN THE OKLAHOMA PANHANDLE.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 6G.
W91-04189

EFFECTS OF IRRIGATION PUMPAGE IN NORTHWESTERN INDIANA, AND THE LEGISLATIVE PROCESS.
Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.
M. E. Basch, and E. J. Crompton.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 455-463, 3 fig, 8 ref.

Descriptors: *Groundwater level, *Groundwater mining, *Indiana, *Irrigation effects, *Legislation, *Water use data, *Wells, Competing use, Domestic water, Groundwater budget, Groundwater resources, Irrigation, Water Rights Emergency Regulation, Water rights, Water use.

Irrigation has been practiced since the early 1950s in Jasper and Newton Counties, Indiana, but did not become widespread until the early 1980s. In 1981, nearly 40 bedrock wells were reported to be effected by groundwater level declines induced by irrigation. From 1982 through 1986, about 100 additional domestic and livestock wells were reported to be affected by irrigation pumpage in Jasper and Newton Counties. Because of this increased pumpage, and the resultant lowering of the groundwater levels which adversely affected domestic and livestock wells in these two counties, the 1982 Indiana General Assembly enacted the Water Rights Emergency Regulation statute. This statute attempted to strike a necessary balance between the need to fully develop the groundwater resource in these two counties, while at the same time protecting the water supplies of domestic users and other owners of small capacity wells. In 1985, the 'Water Rights Emergency Regulation' statute was amended to include all of Indiana. Since the Statewide enactment of the Regulation, the Indiana Department of Natural Resources, Division of Water, has investigated nearly 100 complaints from domestic well owners who believed their water supplies have been affected by adjacent large groundwater withdrawals. About one-third of the investigations revealed that there had been a substantial lowering of groundwater levels, which caused the well failures. Most of the well problems were corrected by the affecting large-capacity users without enacting the provisions of the law. (See also W91-04161) (Lantz-PTT)
W91-04210

PRACTICAL APPLICATION OF THE WATER BALANCE APPROACH FOR MEASURING CANAL CONVEYANCE LOSSES.
Rice (Leonard) Consulting Water Engineers, Inc., Denver, CO.
G. Roush.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 611-619, 1 fig, 2 tab, 3 ref.

Descriptors: *Hydrologic budget, *Irrigation canals, *Irrigation water, *Municipal water, *Water conservation, *Water loss, *Water use, *Water use data, Canals, Case studies, Colorado, Competing use, Consumptive use, Decision making, Water conveyance, Water supply.

Competition for water supplies, especially in areas of population growth, has forced water managers to evaluate various alternative water supplies. A variable usually included as part of the analysis is conveyance loss. Reduction of conveyance losses not only enhances existing water supplies but also the expected yields of future alternative water supplies carried in the same structure. To make sound decisions, water managers need better definition of the canal conveyance losses and gains, than those typically provided by ditch operators. A case study describes a method that can easily be applied to determine the conveyance losses and gains along a ditch. The net conveyance loss along the Church Ditch in Colorado was recently estimated and is the example used in this study. The unlined Church Ditch is more than 26 miles long, has 83 active lateral headgates, and has a current capacity of 82 cu ft/s. At the time conveyance losses were estimated, approximately 35 sq ft/s were being diverted at the headgates. Items presented here include guidelines used to determine the best time for making filed measurements, water measurement techniques used, water balance calculations, results, accuracy of results, man-days involved, and problems encountered. (See also W91-04161) (Author's abstract)
W91-04226

ESTIMATION OF SURFACE-WATER WITHDRAWALS FOR IRRIGATION AND IRRIGATED ACREAGE, 1985, GALLATIN COUNTY, MONTANA.
Geological Survey, Helena, MT. Water Resources Div.
C. Parrett, and D. R. Johnson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 641-647, 1 fig, 2 tab, 5 ref.

Descriptors: *Data interpretation, *Irrigation water, *Selective withdrawal, *Surface water, *Water use, *Water use data, Consumptive use, Flow discharge, Gallatin County, Irrigation canals, Irrigation efficiency, Landsat images, Montana, Surveys, Water conservation.

Periodic discharge measurements and an onsite survey were used to estimate surface water withdrawals for irrigation and irrigated acreage during 1985 in Gallatin County, Montana. On the basis of periodic measurements of discharge at 51 canals, surface water withdrawals for irrigation were estimated to be 386,000 acre-feet. On the basis of a technique of coupling consumptive use with overall irrigation efficiency in the county, withdrawals for irrigation were estimated at 408,000 acre-feet. Irrigated acreage was determined by onsite survey to be 81,500 acres. Irrigated acreage estimates from the US Soil Conservation Service, the Montana Department of Natural Resources and Conservation, and the Montana Department of Agriculture ranged from 94-173% on the onsite surveyed acreage. Visual interpretation of Landsat imagery was used to estimate irrigated acreage for 1985, but the estimate was almost twice as large as the onsite surveyed acreage. The periodic measurement technique for estimating irrigation withdrawals has limitations. Three of the most important are: (1) If discharge in the canals changes substantially between visits, errors in computed volumes can be large; (2) The measurement plan may omit some principle canals; and (3) The measurement plan may omit so many small canals that county totals are affected. (See also W91-04161) (Author's abstract)
W91-04229

FLOAT-POT ASSEMBLY TO MEASURE WATER LEVELS IN AN IRRIGATION CANAL.
Agriculture Canada, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 7B.
W91-04230

ESTIMATION OF GROUND-WATER USE FOR IRRIGATION IN EASTERN WASHINGTON USING LANDSAT IMAGERY.
Geological Survey, Tucson, AZ. Water Resources Div.
P. Van Metre, and P. Seevers.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 667-679, 1 fig, 6 tab, 13 ref.

Descriptors: *Agricultural water, *Data interpretation, *Groundwater irrigation, *Landsat images, *Washington, *Water use, *Water use data, Data acquisition, Groundwater mining, Groundwater resources, Mapping, Remote sensing, Satellite technology.

A method for estimating groundwater pumpage for irrigation was developed for an area of approximately 8,900 square miles on the Columbia Plateau of Eastern Washington. The method combines water application rates estimated from sample data with acreage of irrigated crops mapped using

Landsat imagery. Data from two passes from Landsat's multi-spectral scanner were analyzed to map irrigated crops for the study area. Analysis of data from one pass of the Landsat thematic mapper gave a 6% improvement in accuracy over the multispectral scanner analysis. A total of 576 samples were collected for the 1982-85 irrigation seasons, each sample consisting of an annual water application rate associated with a particular crop. The samples were used to develop a regression equation for estimating annual water application rates as a function of crop type, annual precipitation, available water capacity of the soil, and irrigation system type. Annual water application rates, expressed as a depth of water, then were multiplied by irrigated area as mapped by Landsat to yield volume of water pumped for irrigation in 1985. (See also W91-04161) (Author's abstract)
W91-04232

APPLICATION OF REMOTE SENSING AND GIS TO ESTIMATE IRRIGATION WATER USE IN THE UPPER GUNNISON RIVER BASIN IN COLORADO.
Bureau of Reclamation, Denver, CO.
J. P. Verdin, L. Hall, J. Halls, and P. Davidson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 681-689, 2 fig, 3 tab, 7 ref.

Descriptors: *Databases, *Geographic information systems, *Gunnison River Basin, *Irrigation water, *Remote sensing, *Water use, *Water use data, Aerial photography, Colorado, Consumptive use, Data acquisition, Digital map data, Landsat images, Mapping, Maps, Satellite technology, Water resources data.

A digital geographic database has been assembled for the Upper Gunnison River basin of Colorado to estimate consumptive water use. Irrigated parcels of land were photointerpreted on 1:24,000 scale NHAP (National High Altitude Photography) color infrared prints. Field boundaries were transferred to USGS 7.5 minute quadrangle map bases with reference to USGS orthophoto quadrangle maps. Orthophotos were used to ensure plainimetric accuracy prior to digitation. Each irrigated parcel was digitized with the following attributes: basin, quadrangle name, county, township, range, and section. Irrigation land use attributes were derived from the parcels by digitally overlaying them on vegetation index images prepared from 1987 SPOT (Systeme Probatoire d'Observation de la Terre) and Landsat satellite scenes. The database was designed as a permanent tool which can be reused in future years with new satellite imagery to generate irrigated acreage summaries. Acreage derived for 1987 were used to make consumptive use estimates for the basin. These figures will be compared with water use estimates obtained by conventional sources. (See also W91-04161) (Lantz-PTT)
W91-04233

CONSTANT DISCHARGE DEVICE FOR FIELD IRRIGATION.
Karlsruhe Univ. (Germany, F.R.).
A. P. Larsen, and P. K. Mishra.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 481-489, 1990. 6 fig, 5 ref.

Descriptors: *Flow regulators, *Irrigation, *Irrigation design, *Surface irrigation, Control systems, Design criteria, Field modules, Flow discharge, Irrigation canals.

The delivery of water through a control structure, which maintains constant flow at a known rate, is employed in many surface irrigation systems. A module for constant discharge field outlets was designed and tested in the laboratory. The module was constructed of PVC and Perspex; its dimensions were: 0.1 m width, 0.45 m height, and 1.0 m length. Design discharges between 2 and 7 L/s could be handled within +/-5% with water level variations in the field delivery canal between 15 and 25 cm. This figure was based on experience from Indian field delivery canals. The module has a simple design and contains no moving parts. In order to maintain a constant discharge when the head varies, an internal change of flow structure is accomplished by construction of a series of baffles. The internal width of the module and the baffle dimensions require accurate construction, which, however, could be achieved satisfactorily in most village shops. At a weight of under 10 kg, the module is portable. The module would pass sediment without interfering with its performance. Larger water-logged debris should be prevented from entering the module. (MacKeen-PTT)
W91-04307

EVAPORATION REDUCTION IN STOCK TANKS FOR INCREASING WATER SUPPLIES.
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 3B.
W91-04387

SOILWATER DISTRIBUTION IN A NONUNIFORMLY IRRIGATED FIELD WITH ROOT EXTRACTION.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
R. Wallach.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 137-150, November 1990. 6 fig, 19 ref.

Descriptors: *Irrigation water, *Mathematical equations, *Soil water, *Soil-water-plant relationships, *Sprinkler irrigation, *Unsaturated flow, Hydraulic conductivity, Irrigation design, Pressure head, Soil types, Spatial distribution.

A steady-state solution was developed for two-dimensional distributions of irrigation water flux at the soil surface and water extraction by plant roots. The solution of the linear equation is based on the small perturbations method, in which a small parameter is introduced into the governing differential equation. For the sprinkler irrigation method, this parameter is determined by scaling the soil characteristic length by the distance between the sprinklers. Linearization is attained by assuming that the unsaturated hydraulic conductivity is exponentially related to the pressure head. Vertical distribution of the two-dimensional plant-root uptake is based on the one-dimensional model, which meets the approximation that the extraction pattern of plant roots is 40, 30, 20, and 10% of the total transpiration requirements in each successively deeper quarter of the root zone. Water extraction by plant roots increases lateral unsaturated flow beyond that which occurs as a result of irrigation nonuniformity. However, for a homogeneous soil profile, this lateral flow component increases water availability to those parts of the field where water shortages occur because of irrigation nonuniformity. Indeed, actual irrigation uniformity increases as measured by the decrease in the amplitude of the vertical flux around the mean. Younger plants suffer more from spatial fluctuations of irrigation water than do older plants, which have deeper roots. Actual irrigation uniformity, as measured by water availability to roots, also is affected by the distance between sprinklers and by soil type. (Author's abstract)
W91-04395

REGIONAL COOPERATION IN THE USE OF IRRIGATION WATER: EFFICIENCY AND INCOME DISTRIBUTION.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
For primary bibliographic entry see Field 6C.
W91-04436

RISK-EFFICIENT IRRIGATION STRATEGIES FOR WHEAT.
Western Australia Univ., Nedlands. Inst. of Agriculture.
S. Pandey.
Agricultural Economics, Vol. 4, No. 1, p 59-71, 1990. 1 fig, 4 tab, 36 ref.

Descriptors: *Agriculture, *Economic aspects, *Irrigation, *Irrigation design, *Risk assessment, *Wheat, India, Mathematical models, Plant growth, Water use.

Agricultural production is risky. When farmers are risk averse, they are likely to put a premium on production methods that reduce perceived risks. Irrigation is generally believed to be a risk-reducing input. By using the concept of stochastic dominance, risk-efficient irrigation policies for wheat grown in central India are identified and quantitative estimates of benefits due to risk reductions are obtained. The policy of applying 60 mm of water in growth stages 2, 3, and 4 was found to be risk efficient at low levels of risk aversion. The efficient schedule for a higher level of risk aversion was to skip irrigation in the second stage. This contrasts with the extension advice of applying about 60 mm in each of the four stages. The usual rationale for an intensive irrigation as a risk-reducing strategy is not supported by this study. In fact, increased risk aversion within the preference interval examined resulted in reduced water usage. Such benefits were found to be of a large order of magnitude. The results indicate that benefits in terms of reduction in risk may be a significant proportion of the difference in mean net returns with and without irrigation. The more common methods such as mean variance analysis tended to over-estimate the benefits. (Brunone-PTT)
W91-04437

IMPACT OF INFORMATION ON ENVIRONMENTAL COMMODITY VALUATION DECISIONS.
Georgia Univ., Athens. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W91-04438

COMPARATIVE STATISTICAL VALIDATION OF TWO TEN-DAY WATER-USE MODELS AND OF THREE YIELD-REDUCTION HYPOTHESES FOR YIELD ASSESSMENT IN BOTSWANA.
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
For primary bibliographic entry see Field 6D.
W91-04485

BELLANI EVAPORATION VARIATION IN HILL-LAND PASTURE.
Agricultural Research Service, Beckley, WV. Appalachian Soil and Water Conservation Research Lab.
For primary bibliographic entry see Field 2D.
W91-04486

EXPLOITING RAINY SEASON POTENTIAL FROM THE ONSET OF RAINS IN THE SAHELIAN ZONE OF WEST AFRICA.
International Crops Research Inst. for the Semi-Arid Tropics, Niamey (Niger).
M. V. K. Sivakumar.
Agricultural and Forest Meteorology AFMEEB, Vol. 51, No. 3/4, p 321-332, July 1990. 6 fig, 3 tab, 13 ref.

Descriptors: *Agricultural hydrology, *Agricultural practices, *Climatology, *Crop production, *Precipitation, *Sahel, *Soil-water-plant relationships, *West Africa, Farming, Frequency analysis, Hay, Initial precipitation, Irrigation, Niger, Planting management, Rain, Soil water potential.

Field studies were conducted in Niger during 1986 and 1987 to test the methodology that the potential of the rainy season in the Sahelian zone of West Africa can be determined from the date of onset of rains. An early onset of rains treatment, imposed with supplemental irrigation, was compared with the natural onset of rains. In 1986, natural onset was early, while in 1987 it was considerably late. In both the seasons, dry matter production of millet in the early onset of rains treatment reached 7 t/ha, while late onset resulted in only 3 t/ha. Data on soil water profiles showed that at the time of the millet harvest in the early rains treatment, profile soil water is adequate to establish a second crop of cowpea for hay. This enables efficient exploitation of soil moisture. In addition, the combined water use of the two crops in the early rains

treatment was much higher. Comparison of stored soil water at the time of cowpea harvest with that in the fallow plots after millet revealed no significant difference. Results of this study suggest that by tailoring management tactics to weather conditions, in years with early onset of rains it is possible to establish a second crop of cowpea for hay in the Sahelian zone where the farmers traditionally only grow millet. Some constraints of the millet-cowpea relay crop system include: a labor-intensive bottleneck, insect and bird attacks of the more sensitive short-duration millet cultivars; and the need for millet stalks for livestock feed instead of cowpea mulch. The potential of the system suggested here needs more intensive studies by agronomists, soil scientists, and economists. (Author's abstract)
W91-04488

AQUA, A MODEL TO EVALUATE WATER DEFICITS AND EXCESSES IN TROPICAL CROPPING: PART II. REGIONAL YIELD PREDICTION.

Costa Rica Univ., San Jose. Dept. of Agricultural Engineering.
R. A. Radulovich.

Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 3/4, p 253-261, September 1990. 3 fig, 1 tab, 19 ref.

Descriptors: *AQUA model, *Agricultural hydrology, *Climatology, *Crop yield, *Hydrologic budget, *Model studies, *Regression analysis, *Tropical regions, *Water stress, Beans, Corn, Costa Rica, Crop production, Cropland, Excess rainfall, Hydrologic models, Planting management, Rice.

Rainfed tropical crop production is characterized by variable yield behavior, largely due to as yet poorly quantified and even more poorly managed water deficit and excess effects, together comprising a water stress complex. Indices of water deficit (IDef) and of deficit + excess (IStres) produced with the water balance model AQUA were correlated against rainfed regional yields of one annual planting of rice and beans, and of two planting dates of maize, using data from Costa Rica. It was found that the linear regression model best fitted the data. Although water deficits explained most of the year-to-year yield variability, the regression analysis indicated that a portion of yield reductions are the result of water excess. Yields predicted for 2 years were not significantly different from actual yields, using either index. Yield variability by using IStres was 90% for rice, 70% for beans, and 61% and 83% for first and second maize plantings, respectively. After converting yields to a relative basis, both maize plantings were grouped in one regression analysis and 71% of yield variability was explained by using IStres. After converting yields of all three crops and two maize plantings to their respective relative values, one single regression was run using only deficits through IDef. A simple water balance model like this, that can explain from 60 to 90% of regional yield variability of individual plantings, from 80 to 90% of variability of individual crops, and 76% of the variability of all three crops and planting dates when regressed together, can have many uses such as yield forecasting, crop zoning and regionalization, and a series of analyses of climates and expected responses of crops that at present have only a loose connection with yield. (Fish-PTT)
W91-04494

WORLD GRAIN YIELDS, SNOW COVER, SOLAR ACTIVITY AND QUASI-BIENNIAL OSCILLATION RELATIONSHIPS.

Kansas Univ., Lawrence. Dept. of Physics and Astronomy.
C. M. Laird, R. D. Laird, E. J. Zeller, and G. A. M. Dreschhoff.

Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 3/4, p 263-274, September 1990. 2 fig, 3 tab, 27 ref.

Descriptors: *Climatology, *Crop yield, *Model studies, *Snow cover, *Solar energy, Economic prediction, Grain crops, Meteorology, Regression analysis, Statistical analysis.

Various terrestrial parameters have been used to reconstruct the influence of weather and climate over a range of time intervals and on local to global scales. Grain yield provides a climate index on a relatively short scale, but is controlled by many factors which are the aggregate effects of both natural and human inputs over the course of a crop season. Approximately 70% of the year-to-year variability in world grain yields for 1968-1987 can be explained statistically by a simple linear regression model involving three variables: yields, winter northern hemisphere areal snow cover, and annual solar activity in the preceding year. Eighty-five percent of the world grain yield variability can be explained by this model, due to an enhanced solar signal, in years when the Quasi-Biennial Oscillation is in its west phase. This result is bolstered by recent similar findings by others and supports the detectable impact of solar activity on weather in the stratosphere and troposphere when measured on a global scale. (Fish-PTT)
W91-04495

DETERMINATION OF SOIL WATER EVAPORATION AND TRANSPIRATION FROM ENERGY BALANCE AND STEM FLOW MEASUREMENTS.

Kansas State Univ., Manhattan. Dept. of Agronomy.

For primary bibliographic entry see Field 2D.
W91-04496

EVAPOTRANSPIRATION AND YIELD OF IRRIGATED CHICKPEA.

International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).

For primary bibliographic entry see Field 2D.
W91-04497

PRECIPITATION AND TEMPERATURE REGIMES IN UPLAND BALOCHISTAN: THEIR INFLUENCE ON RAIN-FED CROP PRODUCTION.

International Center for Agricultural Research in the Dry Areas.
D. J. Rees, A. Samiullah, F. Rehman, C. H. R. Kidd, and J. D. H. Keatinge.

Agricultural and Forest Meteorology AFMEEB, Vol. 52, No. 3/4, p 381-396, September 1990. 9 fig, 3 tab, 20 ref.

Descriptors: *Baluchistan, *Climatology, *Crop production, *Pakistan, *Plant-water relationships, *Planting management, *Precipitation, *Temperature effects, Annual precipitation, Cereals, Cold resistance, Drought resistance, Probability studies, Probable maximum precipitation, Seasonal variation, Water stress.

Rainfall and temperature regimes for three contrasting locations in the 200-250 mm annual precipitation zone of upland Balochistan were investigated to determine their implications for crop production. Rainfall dependability throughout upland Balochistan is generally low. Forty-percent of median rainfall occurs during July and August at eastern and southern locations, permitting autumn sowing of winter cereals in six (Loralai) or seven (Khudzar) years in ten; in contrast to western and northern areas (e.g., Quetta), where less than 10% of median rainfall occurs in summer, and autumn sowing can be expected in only two or three years in ten. Cumulative probabilities of sufficient rainfall for spring sowing are 93% for Quetta, but less than 60% for Loralai and Khudzar. Mean maximum and minimum temperatures vary with elevation and location, ranging between 38 and minus 3 C, with up to 99 days below 0 C. The periods within which at least one frost may occur at 50% exceedance probability vary with location from 87 to 161 days. At the higher elevation location, Quetta, low temperatures delay spring planting, in contrast to the other locations where there is no serious temperature restriction for sowing. Upland Balochistan has one of the more severe climates for temperate crop production in West Asia, with low and undependable rainfall (partially relieved by water harvesting practices) and considerable cold stress at elevations above 1500 m. Cold-resistant, drought-tolerant winter crops are required for eastern and southern areas, and drought-resistant, short-season crops for more western and northern areas. (Author's abstract)
W91-04498

CARBON DIOXIDE AND WATER LEVEL EFFECTS ON YIELD AND WATER USE OF WINTER WHEAT.

Kansas State Univ., Manhattan. Dept. of Agronomy.
U. N. Chaudhuri, M. B. Kirkham, and E. T. Kanemasu.

Agronomy Journal AGJOAT, Vol. 82, No. 3, p 637-641, May/June 1990. 3 fig, 3 tab, 24 ref.

Descriptors: *Agronomy, *Carbon dioxide, *Climatology, *Crop yield, *Global warming, *Greenhouse effect, *Water level, *Water requirements, *Water use, *Wheat, Field tests, Grain crops, Plant growth, Soil-water-plant relationships, Transpiration.

The concentration of carbon dioxide (CO2) in the atmosphere has risen from 315 microL/L in 1958 to the present 345 microL/L, increasing at a rate of 1.5 to 2.0 microL/L. Increasing levels of atmospheric carbon dioxide may have major effects on yield and water use of winter wheat (Triticum aestivum L.). The effect of elevated levels of CO2 on grain yield and water use from planting to harvest was studied for two water levels. 'Newton' winter wheat was grown in the field under ambient (340 microL/L) and elevated levels (485, 660, and 825 microL/L) of CO2, during three growing seasons, in 16 underground boxes (77 cm long, 37 cm wide, and 180 cm deep) containing a Muir silt loam. Water in half of the boxes was maintained at 0.38 cu m/cu m (high water level) and in the other half between 0.14 to 0.25 cu m/cu m (low water level). Boxes were weighed in the fall and spring to determine the amount of water use by transpiration. Plastic chambers (121 by 92 by 168 cm) covered the boxes to maintain different CO2 levels. Grain yield of the high-water-level wheat grown under ambient CO2 was about the same as the grain yield of low-water-level wheat grown at the highest level of CO2 (835 microL/L). Similar results were obtained for yield components (spike number, spike weight, kernels/spike, and kernel weight). High-water-level wheat grown with 825 microL/L CO2 transpired more water than low-water-level wheat grown under ambient levels of CO2. Under high and low water levels, 29 and 31% less water was required, respectively, to produce a gram of grain when the CO2 concentration was raised from ambient to 825 microL/L. Results show that the water requirement of wheat is reduced by about 30% by elevated (1.4 times present ambient) CO2. (Author's abstract)
W91-04499

WATER USE BY MONOCROPPED AND INTERCROPPED COWPEA AND SORGHUM GROWN AFTER RICE.

Oregon State Univ., Corvallis. Dept. of Soil Science.
R. A. Morris, A. N. Villegas, A. Polthanee, and H. S. Centeno.

Agronomy Journal AGJOAT, Vol. 82, No. 4, p 664-668, July/August 1990. 1 fig, 6 tab, 17 ref.

Descriptors: *Agronomy, *Crop production, *Planting management, *Soil-water-plant relationships, *Water requirements, *Water use efficiency, Clay loam, Fallowing, Glucose, Grain crops, Hay, Legumes, Pasture management, Precipitation, Rice, Soil water, Sorghum, Water use.

Water remaining in the soil after flooded rice (Oryza sativa L.) is a major source for crops grown during the dry season. To develop improved management systems, quantitative information describing water extraction from previously puddled and flooded fields is needed. Water used by monocropped and intercropped cowpea (Vigna unguiculata L.) and sorghum (Sorghum bicolor L.) treatments grown on a fine, mixed, nonacid isohyperthermic clay loam after harvesting flooded rice was compared to water lost from a fallow treatment. Determinations were to 1.1 m. Water used

before cowpea harvest was similar within a treatment among years, but among treatments monocropped cowpea used 172 mm, monocropped sorghum 135 mm, the intercrop 162 mm, and fallow 121 mm. Water used between cowpea, monocropped sarghum, and the intercrop were 11.3, 12.4, and 16.5 kg glucase/ha/mm. Monocropped cowpea and sorghum harvests ranged from 22 to 118 mm, varying with rainfall after cowpea harvest. Species were compared by expressing grain yields in Mg glucose/hectare required to synthesize grain. Glucose equivalent yields from monocropped cowpea ranged from 1.90 to 1.98 Mg glucose/ha, monocropped sorghum from 1.99 to 3.66 Mg glucose/ha, and the intercrop from 1.99 to 4.36 Mg glucose/ha. Mean water use efficiency by monocropped cowpea and the cowpea-sorghum intercrop each use about 50% more water than is lost from fallow. Whereas the cowpea monocrop and the intercrop use about the same quantities of water when grown during the dry season after rice, the intercrop will use water more efficiently but yields will not be as stable as those from monocropped cowpea. (Author's abstract)
W91-04500

LINE-SOURCE VS. IRRIGATED/NONIRRIGATED TREATMENTS FOR EVALUATION OF GENOTYPE DROUGHT RESPONSE.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). Cereals Program.
V. Mahalakshmi, F. R. Bidinger, and G. D. P. Rao.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 841-844, July/August 1990. 2 fig, 2 tab, 13 ref.

Descriptors: *Agronomy, *Drought resistance, *Irrigation effects, *Soil-water-plant relationships, *Water management, Crop yield, Grain crops, Hay, Performance evaluation, Regression analysis, Screening, Soil water, Sprinkler irrigation, Water deficit, Water stress.

The need for efficient and effective screening for drought response of crops is well-recognized. The line-source sprinkler technique used in many crop breeding programs to evaluate genotype response to drought stress has the advantage over the traditional irrigated/nonirrigated or uniform plot technique in that it creates a continuous range of moisture deficits which permit the estimation of genotype response. In situations where the response is linear, however, the line source may not provide additional information compared to that available from the uniform plot, if both techniques sample the same range of moisture deficits. Field experiments were conducted over two years to compare both screening techniques for evaluating genotype response of pearl millet (Pennisetum glaucum (L.) R. Br.) to water deficit at grain filling. The soil was an Alfisol with approximately 60 mm of plant-available moisture. Mean grain yields for individual positions along the moisture gradient in the line source, and means over genotypes for each replicate in the uniform plot were used as independent variables (environment means) to estimate individual genotype stress response by regression. Predicted genotype grain yield at 250 g/sq m mean yield from the two techniques in either year. Slopes differed in only four of the 32 genotypes in 1982 and two of the eight genotypes in 1984. When genotype response to the stress is linear, the simpler uniform plot technique can be used for preliminary genotype evaluation with little loss of information. (Author's abstract)
W91-04501

SPRINKLER VS. FLOOD IRRIGATION IN TRADITIONAL RICE PRODUCTION REGIONS OF SOUTHEAST TEXAS.
Agricultural Research and Extension Center, Beaumont, TX.
G. N. McCauley.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 677-682, July/August 1990. 7 tab, 25 ref.

Descriptors: *Crop production, *Flood irrigation, *Irrigation requirements, *Rice, *Sprinkler irrigation, *Texas, Cereals, Crop yield, Economic aspects, Evapotranspiration, Grain crops, Plant growth.

Rice (Oryza sativa L.) is a major cereal grain crop that is adapted to flood-irrigated conditions. However, sprinkler irrigation of rice could conserve water and lower production costs. Tests were conducted for three years (1982-1984) on a Beaumont clay soil to evaluate 12 rice cultivars under flood and three levels of sprinkler irrigation. Plant growth (height), plant development (days to heading and harvest), yield, yield components, and quality were monitored. Irrigation treatments were main plots and cultivars were subplots. Irrigation treatments 100, 50, and 25 replaced 100, 50, and 25% of estimated evapotranspiration (ET). Total water applied was 931 mm (1982), 1171 mm (1983), and 1061 mm (1984) for Treatment 100. These applications exceeded the ET of flooded rice by 331 to 571 mm. Compared to flood irrigation, sprinkler treatments reduced plant height by 0.09 to 0.28 m. Days to heading varied by cultivar and irrigation treatment while days to harvest was not affected by the irrigation treatments. Milled grain was not influenced by irrigation. Compared to the average yield for flood irrigation, sprinkler irrigation reduced yield over 20% with Treatment 100 and key cultivar yields were reduced 28%. Yield loss from Treatment 100 could not be attributed to weeds, diseases, or water availability. Yield loss was due to reduced florets/panicle and reduced fertile florets. With a yield differential in excess of 20%, sprinkler irrigation does not appear to be a viable alternative to conventional flood irrigation in traditional rice-growing areas. (Author's abstract)
W91-04502

DIURNAL VARIATION OF CROP HYDRAULIC RESISTANCE: A NEW ANALYSIS.
Hawke's Bay Agricultural Research Centre, Hastings (New Zealand).
For primary bibliographic entry see Field 2D.
W91-04503

ROOT ZONE WATER BALANCES OF THREE LOW-INPUT MILLET FIELDS IN NIGER, WEST AFRICA.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
W. A. Payne, C. W. Wendt, and R. J. Lascano.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 813-819, July/August 1990. 9 fig, 1 tab, 22 ref. United States Agency for International Development grant TropSoils CRSP DAN 1311.

Descriptors: *Agronomy, *Hydrologic budget, *Niger, *Plant water potential, *Rainfall, *Root zone, *Soil-water-plant relationships, Drainage, Evapotranspiration, Grain crops, Hay, Rain gages, Roots, Water supply, West Africa.

It is often assumed that pearl millet (Pennisetum americanum L.) production is limited by water supply despite the fact that little published data exist on water balances of low-input millet fields. A study was conducted on sandy soils in Niger, West Africa, during the 1985 growing season. Fields were near the villages of Chikal, N'Dounga, and Kala Pate, which received 223, 344, and 428 mm of total rainfall, respectively. Water balances were calculated to the depth of maximum root penetration, which was determined at harvest by digging pits. Measurements were made using a field-calibrated neutron probe and nonrecording rain gages. Results indicate that depth of maximum root penetration was not correlated with rainfall received after planting. Seasonal crop water supply was greatest at N'Dounga, where root development was greatest. Drainage below the zone of maximum root penetration was significant at Kala Pate at 43 days after sowing, when cumulative rainfall was only 143 mm, but negligible at the other sites. Drainage could not be separated from evapotranspiration at Kala Pate 67 days after sowing and thereafter. Total evapotranspiration was 272 mm at N'Dounga and 201 mm at Chikal. Cumulative change in water storage in the zone of maximum root penetration was 0 mm at Chikal, 39 mm at N'Dounga, and 46 mm at Kala Pate. Based on the amount of water held above minus 1500 kPa in the zone of maximum root penetration and profile water distribution, it can be concluded that water supply was the primary limiting constraint only at Chikal in 1985. Similar conclusions were obtained using the amount of root zone water held above minus 100 kPa. Water supply may not be assumed a priori to be the primary production constraint to low input millet fields. (Author's abstract)
W91-04504

WATER RELATIONS OF DIFFERENTIALLY IRRIGATED COTTON EXPOSED TO OZONE.
California Univ., Riverside. Statewide Air Pollution Research Center.
P. J. Temple.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 800-805, July/August 1990. 2 fig, 5 tab, 25 ref.

Descriptors: *Air pollution effects, *Drought effects, *Irrigation effects, *Ozone, *Soil-water-plant relationships, California, Cotton, Leaves, Loam, Plant growth, Root development, Soil water, Water stress, Water use.

Cotton (Gossypium hirsutum L.) is grown in areas of the southern and western U.S. where both drought stress and chronic ozone (O3) pollution are known to reduce growth and yield of this economically important crop. A field study was performed to test the hypothesis that plants chronically exposed to O3 may be more susceptible to drought because O3 typically inhibits root growth and increases shoot-root ratios in plants. Cotton was grown in open-top chambers on coarse sandy loam in Riverside, California. Plants were grown under three irrigation regimes: optimum water for lint production (OW), suboptimum or moderate drought stress (SO), and severely drought stressed (SS) and were exposed to seasonal 12-hour (0800-2000) O3 concentrations of 0.015, 0.074, 0.094, or 0.111 microL/L. Leaf xylem pressure potentials and soil water content were measured weekly from June to October. Mean seasonal leaf pressure potentials increased from minus 1.89 MPa to minus 1.72 MPa in low to high O3 treatments, averaged across soil water regimes. Ozone had no effect on seasonal water use of cotton, but water use efficiency was significantly reduced by O3 in OW and SO, but not in SS treatments. Drought-stressed plants extracted proportionally greater amounts of water from deeper in the soil profile than OW cotton, and O3 had no apparent effect on this redistribution of roots in the soil. Since O3 had no apparent effect on the ability of drought-stressed cotton to maintain leaf xylem pressure potentials and to increase root growth relative to shoot growth, this suggests that O3 may have little or no effect on the potential of cotton to adapt to or tolerate drought. (Author's abstract)
W91-04505

TILLAGE AND COVER CROP MANAGEMENT FOR SOIL WATER CONSERVATION.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
A. Munawar, R. L. Blevins, W. W. Frye, and M. R. Saul.
Agronomy Journal AGJOAT, Vol. 82, No. 4, p 773-777, July/August 1990. 1 fig, 7 tab, 22 ref.

Descriptors: *Agricultural practices, *Agronomy, *Conservation tillage, *Cover crops, *Crop yield, *Planting management, *Soil water, *Tillage, *Water conservation, Cereal crops, Corn, Crop production, Fertilization, Grain crops, Kentucky, Nitrogen, Pasture management, Soil surfaces, Soil temperature.

The effectiveness of a conservation tillage system depends on the amount and distribution of plant residues left on the soil surface. The effects of tillage systems, nitrogen (N) fertilizer rates, and cover crop management were determined on soil temperature, soil moisture, and corn (Zea mays L.) yields at a study site in Lexington, Kentucky. Tillage treatments were chisel-plow tillage, conventional tillage (moldboard plowing and disking), disk tillage, and no-tillage. Nitrogen fertilizer at rates of 0, 75, 150, or 225 kg N/ha were broadcast on the soil surface. Rye (Secale cereale L.) on one-half of each split plot was killed 3 weeks before corn planting time, while the other half was al-

lowed to grow until the corn was planted. Corn yields in 1986 were 4.41, 4.03, 3.64, and 2.25 Mg/ha for no-tillage,chisel-plow tillage, disk tillage, and conventional tillage, respectively. The yields were significantly greater with early killed rye (3.85 and 5.05 Mg/ha in 1986 and 1987, respectively). Soil temperature tended to be slightly higher under the late-killed rye mulch in 1986 with no significant difference in 1985. Soil moisture content was significantly higher for early killed rye treatment in the early part of the season in 1986 because there was less soil moisture depletion due to the growing rye. (Author's abstract)
W91-04506

CANOPY TEMPERATURE AND STOMATAL CONDUCTANCE OF WATER-STRESSED DORMANT AND NONDORMANT ALFALFA TYPES.
M. J. Hattendorf, D. W. Evans, and R. N. Peaden.
Agronomy Journal AGJOAT, Vol. 82, No. 5, p 873-877, September/October 1990. 2 fig, 6 tab, 27 ref.

Descriptors: *Agronomy, *Alfalfa, *Canopy, *Soil-water-plant relationships, *Water stress, Air temperature, Crop yield, Sprinkler irrigation, Stomatal transpiration, Vapor pressure, Washington, Water use efficiency.

Alfalfa (Medicago sativa L.) from diverse origins may respond differently to water stress. Dormant and nondormant-type alfalfa response to water stress was assessed by canopy temperature and stomatal conductance. The effects of continuous deficit irrigation produced by a line-source sprinkler system on 'Vernal' (dormant type), 'Vernema' (intermediate dormancy type), and 'CUF 101' (nondormant type) were investigated at Prosser, Washington, on a Warden loam. Water stress was expressed as the Crop Water Stress Index (CWSI), a canopy-temperature-based indicator of water stress. The Y-intercepts of Vernal and CUF 101 canopy air-temperature/vapor pressure deficit curves were significantly different with CUF 101 0.6 C higher than Vernal. Mean canopy resistance to vapor transport was 33% greater for CUF 101 than for Vernal. Slopes of stomatal conductance/CWSI curves were similar, but stomatal conductance at zero CWSI of CUF 101 was 60% of Vernal. Total water use and yields of Vernal, Vernema, and CUF 101 were not significantly different among cultivars, although CUF 101 mean daily water use was 2.1 mm greater than Vernal water use early in the growth cycle. Higher canopy temperature for CUF 101 was consistent with lower CUF 101 stomatal conductance. The differences in canopy temperature and stomatal conductance were related to dormancy type. Lower transpiration of CUF 101 at full canopy cover has implications for development of more water-use-efficient alfalfa. (Author's abstract)
W91-04507

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: I. SOIL AND LEACHATE WATER QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W91-04509

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: II. TURF QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W91-04510

ECONOMIC EFFECTS OF LONG-TERM RESTRICTIONS ON DRAINAGE WATER DISPOSAL.
Rhode Island Univ., Kingston. Dept. of Resource Economics.
For primary bibliographic entry see Field 5G.
W91-04535

EVALUATION OF A SUBSURFACE 'POP-UP' SPRINKLER.
Max C. Fleischmann Coll. of Agriculture, Reno, NV.
W. W. Miller, C. N. Mahannah, R. L. Shane, E. H. Jensen, and W. W. Finke.
Applied Agricultural Research AAREEZ, Vol. 5, No. 1, p 56-62, Winter 1990. 3 fig, 2 tab, 18 ref.

Descriptors: *Agricultural engineering, *Economic evaluation, *Irrigation engineering, *Sprinkler irrigation, *Subsurface irrigation, Cost-benefit analysis, Irrigation design, Nevada, Performance evaluation, Water management.

Most agricultural sprinkler irrigated acreage today is under hand-move or motor-driven systems. The present trend is toward alternatives that are less labor-intensive. Permanent highly-automated systems in which all components are deeply buried are attractive because of the low labor use and in the retraction mode the entire system is removed from potential damage during tillage, harvesting, grazing of livestock, or from vandalism. One unique system, AGRI-POP, in which the riser and rotating sprinklers are completely retractable and extensible, was recently developed. Initial field experience in using this system in western Nevada exposed several design problems. Correcting design flaws resulted in a fully functional system. However, at an investment cost of about $5,601/ha ($2,268/A) greater than the closest solid-set alternative and about $7,000/ha ($2,835/A) greater than the least expensive hand-line system, AGRI-POP presently is not an economically viable alternative for most commercial agricultural applications. Improved economics would result if the system were mass-produced and if relative costs of labor increase. In addition, the system could be particularly useful where strict environmental and water management controls are desired. There may also be some unique recreational and horticultural applications, such as for athletic fields, public parks, golf courses, or other high-traffic areas. (Author's abstract)
W91-04536

EFFECT OF TILLAGE ON SOIL WATER AND ALFALFA ESTABLISHMENT IN CORN STUBBLE.
W. L. Stout, R. A. Byers, C. C. Bahler, and L. D. Hoffman.
Applied Agricultural Research AAREEZ, Vol. 5, No. 3, p 176-180, Summer 1990. 5 tab, 18 ref.

Descriptors: *Agricultural engineering, *Alfalfa, *Cover crops, *Crop yield, *No-till cultivation, *Soil water table, *Soil-water-plant relationships, *Tillage, Corn, Grain crops, Pennsylvania, Seedlings, Silage, Soil conservation, Soil water.

The effect of soil water on alfalfa (Medicago sativa L.) seedling growth during no-till establishment into corn stubble has not been documented. An experiment was performed to evaluate the effects of differences in soil water levels resulting from different tillage methods and seeding dates on alfalfa emergence and seedling growth. The study site was located at the Rock Spring Agricultural Research Center in Centre County, Pennsylvania, on a Hublersburg silt loam soil in 1986 and 1987 and a Hagerstown silt loam soil in 1988. Alfalfa was drilled no-till into stubbles from corn harvested for grain (NT-G), silage (NT-S), or silage plus a rye (Secale cereale L. cv. common) cover crop (NT-SR), and seeded into a conventionally-prepared seedbed resulting from corn harvested for grain (CT). Seeding dates were early April, late April, and mid-May. Soil water content was not adversely affected by the inclusion of the rye cover crop in the NT-SR treatment. Good stands of over 70% seedling frequency were obtained with all treatments, but the NT-S treatment had significantly higher seedling yields, yields at one-tenth bloom, and total seedling year yields than the others. Seedling yields were significantly lower in the NT-SR treatment; however, rye silage yields made this treatment one of the most productive in the seedling year. In addition, the rye cover crop of the NT-SR treatment provides a conservation cover during the winter and a means of capturing nitrate left over from the corn crop or mineralized during the early spring. In the first production year, there was no significant effect of tillage or seeding date on first harvest yields. (Author's abstract)
W91-04537

EFFECTS OF NITROGEN AND WATER MANAGEMENT PRACTICES ON YIELD, GRAIN QUALITY, AND MILLING OUT-TURN OF RICE.
Savannah River Ecology Lab., Aiken, SC.
K. S. Sajwan, D. I. Kaplan, B. N. Mittra, and H. K. Pande.
Applied Agricultural Research AAREEZ, Vol. 5, No. 3, p 198-204, Summer 1990. 1 fig, 7 tab, 17 ref.

Descriptors: *Agricultural engineering, *Agricultural practices, *Agronomy, *Crop yield, *Irrigation design, *Rice, *Water management, Crop production, Fertilization, Grain crops, Nitrogen, Planting management, Submergence.

Nitrogen fertilization and water management are important agronomic practices for creating a suitable field environment for successful production of rice. Field experiments were conducted during both the wet (June-November) and dry (January-May) seasons to study the effects of nitrogen (N) fertilization and water management practices on yield, grain quality, and milling out-turn of rice (Oryza sativa L.). Among varieties, Jaya not only had the greatest yield, it also responded the most to N fertilization. Pusa 2-21 had the poorest grain yields; however, it had the highest protein content, grain hardness, and head yield. Significant improvement in yield, yield attributes, protein content, grain hardness, and head yield was obtained from N applications up to 90 kg N/ha during the wet season and up to 120 kg N/ha during the dry season. Among water management practices, continuous or phasic submergence of the paddy field proved to be more beneficial to the crop than cyclic submergence. However, the beneficial effect of submergence on grain yield was observed only during the dry season. (Author's abstract)
W91-04538

SURFACE WATER MANAGEMENT FOR CROP PRODUCTION ON HIGHLY ERODIBLE LAND.
North Carolina State Univ., Raleigh.
For primary bibliographic entry see Field 4D.
W91-04539

APPLIED WATER REQUIREMENTS FOR SPRINKLER IRRIGATED ALFALFA IN WESTERN NEVADA.
Nevada Univ., Reno. Dept. of Range, Wildlife and Forestry.
M. K. Kimbell, W. W. Miller, C. N. Mahannah, and E. H. Jensen.
Applied Agricultural Research AAREEZ, Vol. 5, No. 4, p 268-275, Fall 1990. 4 fig, 3 tab, 29 ref.

Descriptors: *Alfalfa, *Irrigation, *Irrigation engineering, *Nevada, *Sprinkler irrigation, *Water requirements, *Water use, Arid lands, Crop yield, Evapotranspiration, Farming, Fungicides, Irrigation efficiency, Irrigation water, Model studies, Precipitation.

Applied water production functions may be particularly beneficial in arid areas such as western Nevada. In order to study the usefulness of such functions, four irrigation regimes based on 50, 75, 100, and 125% of the FAO modified Pan Evaporation (irrigation treatments I-IV, respectively) were applied for three years to two fungicide and six cultivar treatments on a 4.9 ha parcel. No significant yield differences were found between fungicide treatments and five of the six cultivars. Significant differences were found in cultivar and bulk field yields between water treatments I and II, and II and III, but not III and IV. Field yields were 15-20% lower than cultivar yields. Polynomial applied water and linear evapotranspiration of alfalfa (ETcrop) production functions were developed. Data over the three-year study period demonstrated a maximum yield of 17 Mg/ha corresponded to an ETcrop of 117 cm, and required 146 cm of

irrigation applied water (IAW). Lower amounts significantly reduced yields. The water requirement derived in this investigation was based on an application efficiency (application uniformity and system irrigation efficiency) of 0.75 for sprinkler irrigated alfalfa in western Nevada. Since water requirements based upon model estimation of ETcrop do not take application efficiency into account, the applied water relationship can help to better delineate potential yield levels under various scenarios of farm delivery water allocation and farm application efficiency. That is, IAW requirement could be adjusted on an individual basis by simply incorporating the appropriate application uniformity, system irrigation efficiency, and localized precipitation. (Author's abstract)
W91-04540

LOCALIZED FIELD IRRIGATION EFFICIENCIES FROM SOIL SALINITY SAMPLES.
Arizona Univ., Tucson.
J. E. Watson, and R. D. Gibson.
Applied Agricultural Research AAREEZ, Vol. 5, No. 4, p 276-279, Fall 1990. 3 fig, 9 ref.

Descriptors: *Agricultural hydrology, *Analytical techniques, *Cropland, *Irrigation efficiency, *Irrigation water, *Saline soils, Arizona, Deep percolation, Estimating equations, Farming, Field tests, Leaching, Root zone, Salts, Soil tests.

Recent trends within the U.S. are encouraging managers of irrigated agricultural operations to carefully evaluate their irrigation practices. Estimation of losses of irrigation water from a field through deep percolation requires that field sampling be carried out. All irrigation waters contain mineral salts. As a result of water removal by the processes of transpiration and evaporation, the concentration of salts remaining in the soil increases. A method has been developed for determining the amount of deep leaching of applied irrigation water, using a relationship between the leaching fraction (the fraction of applied irrigation water that is leached below the crop root zone) and soil salt concentration. The assumptions that must be met for the procedure to work effectively are that (1) the salt concentration of the irrigation water is relatively constant, (2) the time period of concern is much greater than the length of time it takes the water and salt to pass through the root zone, (3) the rate of salt movement through the root zone is relatively constant, and (4) no significant upward flow occurs from a water table. The field variability of the estimated leaching fraction is much less than the variability of the soil salinity samples. A specific site on a grower cooperator's farm near Casa Grande, Arizona, was used as an example. The field site evaluated at 12 separate locations had estimated 'local' efficiencies that ranged from 72% to 87%. The mean field efficiency estimated from these sites was 83%, with a 5% coefficient of variation, based upon the deepest samples taken. The amount of applied irrigation water that annually moved below the root zone was estimated to be about 8.2 acre inches per acre. (Fish-PTT)
W91-04541

SAND CULTURE OF VEGETABLES USING RECIRCULATED AQUACULTURAL EFFLUENTS.
North Carolina State Univ., Raleigh. Dept. of Horticultural Science.
M. R. McMurtry, P. V. Nelson, D. C. Sanders, and L. Hodges.
Applied Agricultural Research AAREEZ, Vol. 5, No. 4, p 280-284, Fall 1990. 2 fig, 4 tab, 20 ref.

Descriptors: *Aquaculture, *Biofiltration, *Culturing techniques, *Farm wastes, *Fish farming, *Soil-water-plant relationships, *Vegetable crops, *Wastewater utilization, *Water reuse, Aquatic plants, Beans, Fish food, Fish management, Foods, Recirculated water, Sand filters, Tilapia, Tomatoes, Water quality.

Benefits of integrating aquaculture and olericulture in a controlled environment include conservation of soil, water, and plant nutrients; production of high-quality food products in close proximity to center of need; and reduction of operating costs. Operation of such a system is applicable wherever fish and fresh vegetables are in high demand. Fish production and biofiltration provided by sand-cultured vegetable crops were linked in a closed system of recirculating water, in order to determine if vegetables growing in sand beds could provide sufficient filtration of recirculated water for fish production and receive adequate mineral nutrition from only fish waters. Blue tilapia (Sarotherodon aureus L.) were stocked as mixed-sex fingerlings at a density of 1.68 kg/cu m (0.105 lb/cu ft). Fish were fed a commercial chow. Greenhouse-grown bush bean (Phaseolus vulgaris L.), cucumber (Cucumis sativus L.), and tomato (Lycopersicon esculentum Mill.) were irrigated with water drawn from the bottom of the tilapia tank for 30 minutes every three hours during the daylight hours. Drainage from the 0.5-m deep sand beds was returned to the fish tank. Each crop was also grown in a sandy loam soil. Feeding 1 kg (2.20 lb) of fish food produced an increase of 0.76 kg (1.68 lb) fish and 1.66 kg (3.66 lb) of vegetables. Both water quality and nutrient content were adequate for tilapia and plant growth in sand culture with no supplemental fertilization. The feasibility of an integrated, recirculatory system for concurrent production of vegetables and fish with no additional fertilizer application was demonstrated. (Author's abstract)
W91-04542

INTENSIVE POTATO PRODUCTION EFFECTS ON NITRATE-N CONCENTRATIONS OF RURAL NEW BRUNSWICK WELL WATER.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
For primary bibliographic entry see Field 5B.
W91-04546

EFFECTS OF FALL SUBSOILING AND SNOW MANAGEMENT ON WATER CONSERVATION AND CONTINUOUS SPRING WHEAT YIELDS IN SOUTHWESTERN SASKATCHEWAN.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
B. G. McConkey, H. Steppuhn, and W. Nicholaichuk.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 225-234, July 1990. 4 fig, 5 tab, 54 ref.

Descriptors: *Agricultural engineering, *Agricultural practices, *Crop yield, *Saskatchewan, *Snow management, *Subsoil, *Tillage, *Water conservation, Canada, Crop production, Economic aspects, Grain crops, Induced infiltration, Infiltration, Precipitation, Root zone, Semiarid lands, Snowmelt, Snowpack, Water resources management, Wheat.

Low amounts and variable distribution of precipitation represent the greatest limitation to crop production in the semiarid portion of the Canadian Prairies. It has been suggested that retaining snow on the field offers the greatest potential for increasing the amount of water available for crops in this regions. The effects of snow management and one-time autumn subsoiling (deep tillage) on grain yields and water conservation for continuous zero-till spring wheat (Triticum aestivum L.) were assessed over a four-year period in two separate experiments in Saskatchewan, Canada. Although snow management practices resulted in a winter snowpack averaging twice that obtained with conventional height stubble, restricted infiltration prevented this water from affecting water conservation or wheat yields. Subsoiling in the autumn to a 35-cm depth substantially increased snowmelt infiltration for the first crop year after the subsoiling. In subsequent years, fall subsoiling did not significantly increase the amount of snowmelt infiltration, although it did increase the depth to which snowmelt had penetrated. Water extraction from the root zone was greater between seeding and harvest under subsoiling. For the four crop years following subsoiling, subsoiling increased grain yields over the control treatment by an average of 7% when conventional height stubble was left, and by an average of 20% when snow management was practiced. The yield benefit from subsoiling persisted for three years when snow management by tall wheat stubble trap strips retained a snowpack equivalent of at least 4.9 cm. However, the overall profitability of one-time fall subsoiling remains to be determined. (Author's abstract)
W91-04549

LONG-TERM SOIL MOISTURE STATUS IN SOUTHERN ALBERTA.
Agriculture Canada, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 2G.
W91-04551

EFFECTS OF POTATO CROPPING PRACTICES ON WATER RUNOFF AND SOIL EROSION.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
For primary bibliographic entry see Field 2J.
W91-04552

EFFECT OF SOIL WATER CONTENT ON THE WINTER SURVIVAL OF WINTER WHEAT, RYE AND TRITICALE.
Agriculture Canada, Sainte-Foy (Quebec). Research Station.
For primary bibliographic entry see Field 2G.
W91-04554

NEW STRATEGIES FOR SOIL CONSERVATION.
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
For primary bibliographic entry see Field 4D.
W91-04561

EFFECTS OF IRRIGATION REGIMES ON YIELD AND WATER USE BY SWEETPOTATO.
Georgia Coastal Plain Experiment Station, Tifton.
D. A. Smittle, M. R. Hall, and J. R. Stansell.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 5, p 712-714, September 1990. 4 tab, 15 ref.

Descriptors: *Crop yield, *Irrigation effects, *Irrigation requirements, *Plant growth, *Soil-water-plant relationships, *Sweet potatoes, *Water use, Hydrological regime, Loam, Moisture tension, Regression analysis, Roots, Sand, Soil water, Water stress.

Sweet potatoes were grown on two soil types in drainage lysimeters under controlled soil water regimes during 1982 and 1983 to determine yield and water use responses. Water regimes consisted of irrigating the sweet potatoes throughout growth when soil water tension at 23 cm exceeded 25, 50, or 100 kPa or by allowing a 100-kPa water stress before root enlargement, during early root enlargement, or throughout root enlargement. Water use and marketable yields were greater when sweet potatoes were grown on a Tifton loamy sand than when grown on a Benifay sand. Water use, marketable yield, and yield of U.S. no. 1 grade roots generally decreased when soil water tensions exceeded 25 kPa before irrigation, although soil water stress of 100 kPa during storage root development did not significantly affect yield. Regression equations were used to describe the relationships of water use to plant age and to compute daily evapotranspiration: pan evaporation ratios (crop factors) for sweet potatoes irrigated at 25, 50, and 100 kPa of soil water tension. Crop factor values for sweet potatoes initially increase and then decrease with age. It was shown that yield of U.S. no. 1 sweet potatoes was greatest with irrigation applications when the soil water tension at 23 cm reached 25 kPa. This irrigation regime also required more water than did irrigation at 50 and 100 kPa throughout growth or when a 100-kPa water stress occurred before or after initiation of storage root development. (Author's abstract)
W91-04564

RESPONSE OF SEED CARROT TO VARIOUS WATER REGIMES: I. VEGETATIVE GROWTH AND PLANT WATER RELATIONS.
Agricultural Research Service, Fresno, CA. Water Management Research Lab.
For primary bibliographic entry see Field 2I.
W91-04565

RESPONSE OF SEED CARROT TO VARIOUS WATER REGIMES: II. REPRODUCTIVE DEVELOPMENT, SEED YIELD, AND SEED QUALITY.
National Forage Seed Production Research Center, Corvallis, OR.
J. J. Steiner, R. B. Hutmacher, A. B. Mantel, J. E. Ayars, and S. S. Vail.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 5, p 722-727, September 1990. 7 fig, 2 tab, 13 ref.

Descriptors: *Carrots, *Irrigation requirements, *Plant growth, *Seeds, *Soil-water-plant relationships, Crop yield, Drought effects, Evapotranspiration, Germination, Hydrological regime, Loam, Mature growth stage, Moisture tension, Roots, Sand, Soil moisture deficiency, Soil water, Water stress.

The seed carrot plant (Daucus carota L. var. sativa DC.) grows in an indeterminate fashion, producing seed in umbels that arise from multi-rank ordered branches. As a result, there is a great deal of variability in the maturity of the seed at harvest. Seed yield and quality of carrot are influenced by a wide range of water application regimes and levels. Irrigation treatments were imposed beginning at the time of extension of the primary umbel and extending throughout the reproductive development period. The three application regimes used were: (1) a high-frequency, low-water deficit treatment (100% of daily accumulated crop evapotranspiration (ET)); (2) a series of five low-frequency (irrigated after 30 mm of accumulated ET) application treatments with a range of water deficits from moderate to minimal (40% to 120% of ET applied); and (3) a series of three treatments that had rapidly developing water deficits applied by terminating irrigation at 7, 5, and 2 weeks before harvest after being grown under low-stress conditions. Pure live seed was optimized by different treatments within each of the three application regimes. Maximum yields were achieved with short-term (2-week) rapidly developing water deficits near harvest, moderate deficit irrigation with 60% to 80% of ET applied after 30 mm of ET or with a low water deficit, high-frequency application. Seed germination percentage decreased as the amount of applied water increased. This effect was more pronounced in the later-developing umbel orders. However, seed quality measured as seedling root length was improved with increasing water application. (See also W91-04565) (Author's abstract)
W91-04566

YIELD OF SUCCESSIVELY CROPPED POLYETHYLENE-MULCHED VEGETABLES AS AFFECTED BY IRRIGATION METHOD AND FERTILIZATION MANAGEMENT.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
G. H. Clough, S. J. Locascio, and S. M. Olson.
Journal of the American Society for Horticultural Science JOSHB5, Vol. 115, No. 6, p 884-887, November 1990. 8 tab, 13 ref.

Descriptors: *Crop yield, *Fertilization, *Irrigation effects, *Irrigation engineering, *Mulching, *Planting management, *Soil-water-plant relationships, *Vegetable crops, Broccoli, Drip irrigation, Loam, Nitrogen, Potassium, Sand, Tomatoes.

While the value of irrigation or mulch in the production of vegetable crops has been well documented, irrigation and mulch used together can greatly increase yields over either used alone. Broccoli (Brassica oleracea L. var. italica), followed by tomato (Lycopersicon esculentum Mill.) or squash (Cucurbita pepo L. var. melopepo), and then broccoli were produced in succession re-using the same polyethylene-mulched beds at two location with different soil types. First-crop broccoli yield was earlier and greater with drip than with overhead irrigation and increased as N-K rate increased from 135-202 to 270-404 kg/ha. On a fine sandy soil, yields of second and third crops produced with residual or concurrent fertilization increased with an increase in N-K rate. On a loamy fine sandy soil, yields also increased as the rate of residual N-K increased; yields of second and third crops did not respond to rate of concurrently applied N-K, but were higher with concurrent than with residual fertilization, except total tomato yields were similar with either application time. With drip irrigation and concurrent weekly fertigation, yields equalled or exceeded those obtained with preplant fertilization and overhead irrigation. (Author's abstract)
W91-04567

SOIL TEMPERATURE UNDER CONVENTIONAL AND MINIMUM TILLAGE: SIMULATION AND EXPERIMENTAL VERIFICATION.
Alberta Univ., Edmonton. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-04582

SOIL SALINITY: IRRIGATION PRACTICES AND EFFECTS ON CROPS AND GROUND WATER (JAN 77--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3C.
W91-04649

IRRIGATION EFFECTS ON PLANT WATER RELATIONS AND PRODUCTIVITY OF THOMPSON SEEDLESS GRAPEVINES.
California Univ., Davis. Dept. of Viticulture and Enology.
D. W. Grimes, and L. E. Williams.
Crop Science CRPSAY, Vol. 30, No. 2, p 255-260, March/April 1990. 5 fig, 2 tab, 28 ref.

Descriptors: *Crop production, *Fruit crops, *Irrigation, *Irrigation effects, *Irrigation programs, *Plant physiology, *Plant water potential, *Soil-water-plant relationships, *Vine crops, *Water requirements, California, Evapotranspiration, Model studies, Planting management, Soil types, Water resources management.

An optimum irrigation management strategy requires information on the yield loss associated with quantified field water deficits and the ability to assess the adequacy of irrigation intensity during the growing season. A water production function was developed for grape (Vitis vinifera L.) and plant-based water-status measurement techniques and critical values that assess irrigation regime adequacy were established. Field studies were conducted for three years with Thompson Seedless grapevine on Panoche clay loam (fine-loamy, mixed (calcareous), thermic Typic Torriothent) and Hanford sandy loam (coarse-loamy, mixed, non-acid, thermic Typic Xerorthent) in the San Joaquin Valley of California. Differential irrigation quantities were supplied in several increments ranging from 40 to 120% of the expected nonstressed crop evapotranspiration. Midday measurements of leaf water potential, crop water stress index (CWSI), and stomatal conductance were closely associated with imposed water deficits and the resulting grape yields. All plant-based water-status reflecting measurements were highly correlated. Grape yields followed declining water availability essentially linearly over the range of available data. A 50% reduction in expected nonstress crop evapotranspiration resulted in a 26% yield loss. Irrigation intensities that resulted in leaf water potential $>$ -0.9 MPa, CWSI $>$ 0.2, and stomatal conductance $>$ 0.008 m/sec maintained high grape productivity. These results can be used to profit-maximize irrigation water as a production input. (Author's abstract)
W91-04780

CARBON ISOTOPE DISCRIMINATION: POTENTIAL IN SCREENING COOL-SEASON GRASSES FOR WATER-LIMITED ENVIRONMENTS.
Agricultural Research Service, Logan, UT.
D. A. Johnson, K. H. Asay, L. L. Tieszen, J. R. Ehrlinger, and P. G. Jefferson.
Crop Science CRPSAY, Vol. 30, No. 2, p 338-343, March/April 1990. 2 fig, 3 tab, 26 ref. USDA Crop Science Research Center Grant No. 86-CRSR-2-2962.

Descriptors: *Carbon isotopes, *Environmental effects, *Grasses, *Limiting factors, *Plant-water relationships, *Water use efficiency, Genetics, Irrigation effects, Photosynthesis, Plant water potential, Seasonal variation, Water resources management.

Carbon isotope discrimination (delta) has been shown to be negatively related to water use efficiency (WUE) in several C-3 crop species and has been proposed as a criterion to select for improved WUE in plant breeding programs. Whether delta is related to WUE in crested wheatgrass (Agropyron desertorum and Altai wildrye (Leymus angustus was studied and the influence of drought on the magnitude of genetic variability and broad-sense heritability of delta among clones of crested wheatgrass was evaluated. In a greenhouse pot experiment, delta was negatively related to WUE in crested wheatgrass (r = -0.73, significant at $P <$ 0.01) and Altai wildrye (r = -0.81). In field studies, a line-source sprinkler system operated in conjunction with an automated rainout shelter imposed a continuously variable water application on 29 vegetatively propagated clones of crested wheatgrass. Three water levels along the water application gradient were selected for sampling and forage dry weights and delta values were determined for two harvests in 1986 and one harvest in 1987. In the field experiment, delta declined as less water was applied and was positively associated with forage yield at each of the three harvests (r = 0.59, 0.44, and 0.80, respectively). Significant variability for delta was detected among the clones for the two peak-season harvests, but not for the late-season harvest in 1986. Broad-sense heritability for delta was 0.49 in the analysis of data combined over harvests and water levels. Genetic variances and broad-sense heritabilities (H) for delta were generally greater at the high (H = 0.52) and intermediate (H = 0.52) water applications than at the low water applications (H = 0.37), and coefficients of variation for delta were typically less than 4.5%. Selection for delta appears to be a promising screening tool for the development of crested wheatgrass populations that are productive and make efficient use of limited water resources. (Author's abstract)
W91-04781

CORN, SORGHUM, AND SOYBEAN RESPONSE TO IRRIGATION IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN.
Agricultural Research Service, Stoneville, MS. Soybean Production Research Unit.
L. G. Heatherly, R. A. Wesley, and C. D. Elmore.
Crop Science CRPSAY, Vol. 30, No. 3, p 665-672, May/June 1990. 8 tab, 12 ref.

Descriptors: *Corn, *Crop production, *Irrigation requirements, *Mississippi River, *Soil-water-plant relationships, *Sorghum, *Soybeans, Economic aspects, Plant physiology, Seasonal variation, Soil types, Water resources management, Weeds.

The most agronomically efficient use of irrigation water is for those crops that give the greatest response. In the Mississippi River alluvial plain, the primary irrigated crop is soybean (Glycine max (L) Merr.), but the response of soybean to irrigation has not been compared to that of other crops. Irrigated and nonirrigated experiments were conducted from 1984 through 1987 on Tunica clay (clayey over loamy, montmorillonitic, nonacid, thermic Vertic Haplaquept) to determine the effect of irrigation on field-grown corn (Zea mays L.), sorghum (Sorghum bicolor (L.) Moench), and soybean yield and yield components. Shifts in weed species composition resulting from continuous monocropping with these crops also were quantified. Irrigation was applied from beginning bloom to near maturity of each crop whenever soil water potential at the 30-cm soil depth averaged about -70 kPa. Irrigation did not consistently affect weed

cover in any of the crops. Weed level differences among crops resulted from different weed control programs for each continuous cropping system. Differences between average seed yields of irrigated (I) and nonirrigated (NI) corn, sorghum, and soybean were 2886, 694, and 1574 kg/ha, respectively. Sorghum produced the most stable nonirrigated yield and the smallest increase in monetary return from irrigation. Differences between I and NI corn and soybean yields were associated with increased number of seed. Smaller sorghum yield differences were associated with differences in seed weight or a combination of differences in seed weight and number of seed. Across the 4 years, irrigation of corn and soybean produced nearly equal increases in gross income per unit of land area, but irrigation efficiency for soybean was lower because achieving the increased return from irrigation required nearly twice as much water for soybean as for corn. (Author's abstract)
W91-04782

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

ECOLOGY AND MANAGEMENT OF WATER PLANTS IN LOWLAND STREAMS.
F. H. Dawson.
Annual Report - Freshwater Biological Association FBARAD, p 43-60, 1989. 7 fig, 27 ref.

Descriptors: *Aquatic plants, *Aquatic weed control, *Environmental control, *Plant growth, *Stream ecology, Biomass, Economic aspects, Flood control, Light effects, Limiting nutrients, Research priorities, Species composition, Vegetation regrowth.

Growth of water plants in lowland streams is particularly vigorous in unshaded areas during the spring and summer. This can cause stream levels and soil water tables to rise increasing the risk of summer flooding. Cutting the plants during the spring and summer has proved to be only a short-term solution since reducing biomass in the stream accelerates conditions for regrowth. Alternative control techniques based on knowledge of the biology of the plants and their environmental interactions include changes in the timing and extent of cutting, manipulating the plant's environment through use of shading, regulating the supply of nutrients, and changing the quantity or species composition of plant communities. Such techniques should seek to reduce ecological stress and management effort, but information is still required on both basic data and cost/benefit analyses of current methods, and biological studies of the problem plants. (Doyle-PTT)
W91-03968

GOAL-PROGRAMMING TECHNIQUES FOR OPTIMAL RESERVOIR OPERATIONS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W91-03994

AGRICULTURAL CHEMICAL MANAGEMENT PRACTICES TO REDUCE LOSSES DUE TO DRAINAGE.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-04006

IMPLICATIONS FOR THE DESIGN OF ARTIFICIAL LAKES OF A STUDY OF THE CRAIGAVON LAKES.
Ulster Univ., Ballyronan (Northern Ireland). Freshwater Lab.
B. Rippey.
Water Research WATRAG, Vol. 24, No. 9, p 1085-1089, September 1990. 1 fig, 3 tab, 22 ref.

Descriptors: *Artificial lakes, *Design criteria, *Eutrophic lakes, *Phosphorus, *Urban runoff, *Water quality, Aquatic plants, Flood control, Macrophytes, Northern Ireland, Recreation, Shallow water, Storm water management, Water depth.

Two linked artificial lakes in the new town of Craigavon in Northern Ireland are used for both stormwater management and recreation. The eutrophic lakes have not only fulfilled their engineering function of preventing flooding from urban runoff but the water quality has been high enough to allow recreation on and beside them. A study of water quality has shown that phosphorus loading-trophic state models apply to these artificial lakes. These models may be able to be used elsewhere to achieve optimum design and acceptable water quality. The phosphorus loading-trophic state models may be used to explore how water quality varies with lake depth and decide if the costs of excavation of deeper lakes are justified. When deciding which areas should drain to an artificial lake, estimates of the water quality can be made and the best solution chosen. The high cost of excavating lakes means that most of the lakes will be fairly shallow. The growth of macrophytes in the shallow lakes can be controlled by yearly mechanical cutting. (Geiger-PTT)
W91-04037

SELECTIVE MEDIUM FOR ISOLATION OF MYCOLEPTODISCUS TERRESTRIS FROM SOIL SEDIMENTS OF AQUATIC ENVIRONMENTS.
EcoScience Labs., Inc., Amherst, MA.
For primary bibliographic entry see Field 7B.
W91-04063

INVENTORY OF INTERBASIN WATER TRANSFERS IN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04172

LAND USE PRACTICES AND WATER DISPUTES.
Auburn Univ., AL. Water Resources Research Inst.
For primary bibliographic entry see Field 6E.
W91-04205

FLOW CHARACTERISTICS OF STREAMS THAT DRAIN THE FORT APACHE AND SAN CARLOS INDIAN RESERVATIONS, EAST-CENTRAL ARIZONA, 1930-86.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-04469

MOVEMENTS AND HABITAT USE BY GRASS CARP IN A LARGE MAINSTREAM RESERVOIR.
Alabama Cooperative Fishery Research Unit, Auburn.
For primary bibliographic entry see Field 2H.
W91-04593

STREAMFLOW CHARACTERISTICS OF SMALL TRIBUTARIES OF ROCK CREEK, MILK RIVER BASIN, MONTANA, BASE PERIOD WATER YEARS 1983-1987.
Geological Survey, Helena, MT.
For primary bibliographic entry see Field 2E.
W91-04634

REMARKS ON THE APPLICATION OF A RISK-AVERSE APPROACH TO THE MANAGEMENT OF 'EL CARRIZAL' RESERVOIR.
Brescia Univ. (Italy). Dipt. di Automazione Industriale.
For primary bibliographic entry see Field 6A.
W91-04827

URBAN STORMWATER: AN OVERVIEW FOR MUNICIPALITIES.
Woodward-Clyde Consultants, Oakland, CA.
For primary bibliographic entry see Field 5B.
W91-04848

MANAGING A LAKE FOR WATER CONTROL AND WETLANDS CREATION.
Black and Veatch, Kansas City, MO.
W. N. Keith, and S. L. Ketchum.
Public Works PUWOAH, Vol. 121, No. 13, p 43-45, 67, December 1990.

Descriptors: *California, *Lake management, *Reservoir operation, *Water conservation, *Wetlands, Development, Inlets, Lake Elsinore, Pumping plants, Riparian land, Water management, Well rehabilitation.

With ever growing demands on a finite supply, water conservation is a familiar element in Southern California public works planning. An area experiencing such growing pains is the City of Lake Elsinore, located approximately 70 miles southeast of downtown Los Angeles. Lake Elsinore is the only natural reservoir in the watershed. The lake has a large surface area that because of the dry climatic conditions loses tremendous amounts of water to evaporation. As a result of the receding water surface that is due to this evaporation, building development tends to advance toward the lake edges, and flooding (although rare) is devastating. Therefore, a multi-purpose water conservation project was designed. Included in the project were plans for a main levee; well rehabilitation, lake-type inlet, and island grading; a channel-type inlet, pumping station, and wetlands grading; and wetlands habitat and planting. This plan will result in constraining the lake fluctuations within a 22-ft range that will eliminate many of the problems caused by the unmanaged conditions. Developing 340 acres of adjacent land into wetlands and a one-mile long linear riparian habitat feature will also enhance the lake area and contribute to management goals. An ongoing aspect of the project is a series of workshops held in conjunction with federal and state resource agencies. Because several agencies have a legitimate interest in the Lake Elsinore Lake Management Project, its success hinges largely on effective teamwork. (White-Reimer-PTT)
W91-04849

MULTIPURPOSE STORMWATER DETENTION PONDS.
Wright Water Engineers, Inc., Denver, CO.
J. E. Jones.
Public Works PUWOAH, Vol. 121, No. 13, p 52-53, December 1990.

Descriptors: *Aesthetics, *Detention ponds, *Storm runoff, *Storm water management, *Urban hydrology, Design criteria, Drainage, Multipurpose ponds, Water quality.

Multipurpose detention pond concepts for both 'wet' ponds (those that maintain water permanently) and 'dry' ponds (those that retain stormwater briefly during and after floods) are summarized. Regardless of the specific functions that the designer attempts to fulfill, the pond must be: (1) safe, from the standpoint of public visitors or users of the facility; (2) hydrologically and hydraulically sound; (3) maintainable at low cost; (4) structurally sound if a severe flood occurs, possibly up to the probable maximum flood; and (5) pleasant to view; considered an asset rather than a nuisance. Specific purposes for stormwater detention ponds other than runoff containment include: (a) water quality enhancement; (b) enhanced property values and community focal points; (c) wildlife habitat enhancement; and (d) active recreational potential. Unfortunately, many ponds are built because a developer had to demonstrate that 'post-development discharges will not exceed pre-development discharges.' Detention pond design needs to be for more than this. It is incumbent upon the drainage designer to evaluate multiple purpose objectives for wet and dry stormwater detention ponds. (White-Reimer-PTT)

W91-04851

4B. Groundwater Management

PROTECTING GROUND WATER FROM THE BOTTOM UP: LOCAL RESPONSES TO WELLHEAD PROTECTION.
For primary bibliographic entry see Field 5G.
W91-03921

CASE STUDY OF REGIONAL EFFORT: WELLHEAD DELINEATION AS A TOOL FOR FOSTERING REGIONAL COOPERATION.
North Kingstown Dept. of Planning and Development, RI.
For primary bibliographic entry see Field 5B.
W91-03924

AQUIFER PROTECTION THROUGH LARGE SCALE COMPUTER MODELLING.
Dufresne-Henry, Inc., Westford, MA.
D. F. Edson.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 119-121.

Descriptors: *Aquifer management, *Computer models, *Groundwater management, *Groundwater quality, *Massachusetts, *Model studies, *Water pollution control, *Water pollution prevention, *Wellhead protection, Groundwater, Groundwater pollution, Groundwater resources, MODFLOW model.

The Barnes Aquifer, one of the largest in central and western Massachusetts, extends over the eastern portion of the City of Westfield. The City has developed six wells in this aquifer, each producing between 1,400 and 1,600 gallons per minute, representing 90% of the water supply capability of the aquifer. In 1985, the City enacted a set of aquifer protection bylaws and developed a wellhead protection district map based upon surficial geology and topography. In 1989, a more detailed and thorough delineation of wellhead protection areas was completed by use of a large scale hydrogeologic computer modeling. Wellhead protection areas were detailed using MODFLOW, a three-dimensional finite difference groundwater flow model developed by the US Geologic Survey (USGS). The area modeled was 14,000 feet by 32,000 feet, represented by a 33 by 70 grid system yielding 2,310 model nodes. Node spacing varied between 400 and 900 feet. Aquifer characteristics incorporated into the model included aquifer permeability, saturated thickness, storativity, initial head distribution, induced infiltration from surface water bodies, till barrier boundaries, and pumping well withdrawal rates. The data were obtained from City well testing records and a USGS water resource investigation of the area. Wellhead protection districts were developed based upon criteria contained in Massachusetts state guidelines for Zone II, which includes 180 days of continuous pumping with no recharge from precipitation. (See also W91-03921) (Tappert-PTT)
W91-03929

REAL-TIME APPROACH TO MANAGEMENT AND MONITORING OF GROUNDWATER HYDRAULICS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2F.
W91-04128

GROUND-WATER BANKING IN KERN COUNTY, CALIFORNIA.
Kern County Water Agency, Bakersfield, CA.
S. T. Pyle.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 251-260, 1 fig, 2 tab.

Descriptors: *California, *Conjunctive use, *Groundwater management, *Groundwater storage, *Water resources management, *Water use data, Groundwater budget, Water supply, Water use.

Groundwater banking is an emerging water management technique that uses groundwater storage capacity in the same manner as a surface water reservoir. Conjunctive use of surface water and groundwater is a well developed practice where both sources are available. Water and irrigation districts are able to augment water supplies by conjunctive use with recharge programs to conserve excess surface water and by installing wells to pump groundwater into canals otherwise used for distribution of surface water. These programs are operated using the groundwater storage basin as a common pool. Groundwater banking depends on similar physical practices and on the legal authority of an entity (municipality or water or irrigation district) to store a specific volume of water and to reclaim the same volume of water. Conjunctive use programs are presented as part of this study, which have been forerunners of banking as well as groundwater banking programs now in operation and plans for expansion of the banking concept. (See also W91-04161) (Author's abstract)
W91-04190

SOCIALLY OPTIMAL AND MARKET UTILIZATION OF GROUND-WATER RESOURCES.
National Ecology Center, Fort Collins, CO.
A. J. Douglas.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 261-272, 13 ref.

Descriptors: *Economic aspects, *Groundwater management, *Groundwater resources, *Water resources management, *Water use data, Aquifers, Groundwater budget, Groundwater pumping, Groundwater storage, Model studies, Pumping.

The tools and techniques of neoclassical economic analysis were applied to the study of the socially optimal and market application of groundwater resources. The analysis was based on three papers that apply modern mathematical control theory to the problem of selecting optimal dynamic strategies for the management of groundwater resources. The economic implications of these mathematical models are condensed and summarized. Perhaps the most sweeping issue investigated is that of conserving the resource. Results indicate that the level of storage yields certain non market benefits. In cases in which there is an optional stationary rate of pumping and storage, the model analyzes the impacts of shifts in various economic parameters including the cost of pumping and the rate of discount. (See also W91-04161) (Lantz-PTT)
W91-04191

WATER CONSERVATION, MYTH OR MANDATE, AN ARID SOUTHWEST PERSPECTIVE.
Las Vegas Valley Water District, NV.
For primary bibliographic entry see Field 6D.
W91-04192

WELL FIELD MANAGEMENT FOR OPERATIONAL EFFICIENCY.
Texas Tech Univ., Lubbock.
B. J. Claborn, and K. A. Rainwater.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 361-370, 1 fig, 2 tab, 12 ref.

Descriptors: *Groundwater management, *Water resources management, *Water use data, *Well fields, Aquifers, Conservation, Costs, Groundwater resources, Model studies, Simulation analysis, Water supply.

Many municipalities rely on groundwater for at least a portion of their water supply; the groundwater for a city is usually collected from an existing well field. A major component of the operational expense is the power cost for pumping, which includes the vertical lifts and the head losses through the collection piping to the storage facility. When the demand served by the well field is significantly less than its total capacity, there is a potential for energy efficient management decisions as the wells are selected to meet that demand. Such decisions should consider both transient drawdown at each well, and the energy losses between the wells and the storage facility. A simulation model has been assembled for use with microcomputers to assist an operator with these decisions. Input information includes hydraulic parameters for the aquifer, wells and collection system. For a given demand, the model output provides an estimate of the best combination of wells to meet that flow rate. (See also W91-04161) (Author's abstract)
W91-04200

EFFECTS OF IRRIGATION PUMPAGE IN NORTHWESTERN INDIANA, AND THE LEGISLATIVE PROCESS.
Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.
For primary bibliographic entry see Field 3F.
W91-04210

CAN CONTAMINATED, FRACTURED, POROUS AQUIFERS BE RESTORED.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 5G.
W91-04311

GROUNDWATER RESOURCES DEVELOPMENT IN THE EASTERN SAHARA.
Birmingham Univ. (England). Hydrogeology Section.
J. W. Lloyd.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 71-87, November 1990. 14 fig, 1 tab, 26 ref.

Descriptors: *Arid lands, *Groundwater potential, *Sahara, *Water resources development, Aquifers, Developing countries, Economic aspects, Egypt, Groundwater mining, Industrial water, Irrigation water, Libya, Nile River, Sudan, Water supply.

In the eastern Sahara groundwater is present in a range of geological strata and has been used for centuries for small-scale potable supplies and for irrigation. Increasing pressure of population and industrial development, and the uncertainty of Nile River flow in the Sudan and Egypt, are focusing unprecedented attention on the groundwater potential. Studies of groundwater in this area stimulated by this increasing water requirement have demonstrated that major groundwater resources exist that can be developed by abstraction adjacent to the River Nile, by groundwater mining or by abstraction from throughflow. Groundwater originating from paleo-recharge is abundant in the Nubian sandstone aquifer and associated Tertiary aquifers in the northeastern Sahara. Much of the groundwater is of extremely good quality and can be used for development by abstraction and aquifer storage manipulation close to the Nile, by mining in the unconfined areas and by abstraction from throughput in the confined areas. The potential for groundwater abstraction is considerable and water availability should not constrain industrial and irrigation development. To avoid problems of developing the desert, the Libyan government has chosen to convey groundwater to the population at the coast. The solution is extremely expensive but is the most logical under the present circumstances and may point the way to groundwater development elsewhere in the region. Without similar conveyance schemes, groundwater development may not have the impact that would be expected from the vast resources that are present beneath the northeastern Sahara. (Rochester-PTT)
W91-04391

GEOTHERMAL RESOURCES OF THE WESTERN ARM OF THE BLACK ROCK DESERT,

NORTHWESTERN NEVADA: PART II, AQUEOUS GEOCHEMISTRY AND HYDROLOGY.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2K.
W91-04462

CONCEPT OF THE SHALLOW GROUNDWATER SYSTEM ALONG THE NORTH PLATTE RIVER, SOUTH-CENTRAL WYOMING.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04463

ESTIMATES OF CONSUMPTIVE USE AND GROUND-WATER RETURN FLOW AND THE EFFECT OF RISING AND SUSTAINED HIGH RIVER STAGE ON THE METHOD OF ESTIMATION IN CIBOLA VALLEY, ARIZONA AND CALIFORNIA, 1983 AND 1984.
Geological Survey, Tucson, AZ. Water Resources Div.
S. J. Owen-Joyce.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4194, 1990. 41p, 15 fig, 5 tab, 21 ref. Project No. AZ085.

Descriptors: *Arizona, *California, *Cibola Valley, *Consumptive use, *Irrigation-return flow, *Return flow, *Water use, Agriculture, Evapotranspiration, Hydrologic systems, Irrigation water, Lower Colorado River, Phreatophytes, Southwestern United States, Vegetation, Water level.

In Cibola Valley, Arizona, water is pumped from the Colorado River to irrigate crops and to maintain wildlife habitat. Unused water percolates to the water table and, as groundwater, moves downgradient into areas of phreatophytes, into a drainage ditch, out of the flood plain, and back to the river. In 1983 and 1984, groundwater return flow was negligible because in most of Cibola Valley the river lost water to the aquifer. Evapotranspiration was used as an approximation for consumptive use by vegetation. Evapotranspiration was calculated as the sum of the products of the area of vegetation types and water-use rate by vegetation type. Evapotranspiration was estimated to be 70,100 acre-ft in 1983 and 62,600 acre-ft in 1984. These estimates may be in error because of the effect of sustained inundation on the rate of water use by phreatophytes. The effects cannot be quantified and therefore adjustments to rates calculated for dry-surface conditions could not be made. The method of estimating consumptive use of water by vegetation and groundwater return flow is affected by changing conditions during years of rising and sustained high river stage caused by flood-control releases at Parker Dam. Most of the bank storage that will return to the river when the high river stage subsides did not originate as irrigation water. High river stage caused some areas to be flooded directly or raised groundwater levels above the land surface. No crops could be grown in flooded fields. The decreased depth to water and inundation with fresh water resulted in new phreatophyte growth in some areas. In some areas that were flooded, many phreatophytes died. Changes in the inundated and flooded areas throughout the years made it difficult to estimate the evaporation losses from the increased water surface. (USGS)
W91-04465

GROUND-WATER RESOURCES OF HONEY LAKE VALLEY, LASSEN COUNTY, CALIFORNIA, AND WASHOE COUNTY, NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04466

GROUND-WATER WITHDRAWALS, WATER-LEVEL CHANGES, LAND-SURFACE SUBSIDENCE, AND GROUND-WATER QUALITY IN FORT BEND COUNTY, TEXAS, 1969-87.
Geological Survey, Austin, TX. Water Resources Div.
G. L. Locke.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4012, 1990. 155p, 17 fig, 7 tab, 31 ref.

Descriptors: *Aquifers, *Compaction, *Geohydrology, *Groundwater resources, *Subsidence, *Water use, Compressibility, Irrigation wells, Pumpage, Specific conductance, Water level, Water quality.

Fort Bend County, Texas, one of the fastest growing counties in the U.S., is dependent entirely on groundwater for public supply. Withdrawals for public supply increased from 4 Mgal/d (million gallons per day) in 1969 to 28 Mgal/d in 1986. Total withdrawals increased from 56 Mgal/day in 1969 to 72 Mgal/day in 1982, but decreased because of reductions in irrigation withdrawals, to 53 Mgal/d in 1986. The net decline in the potentiometric surfaces from 1969 to 1987 ranged from less than 4 ft in the upper unit and 100 ft in the lower unit of the Chicot aquifer to 125 ft in the Evangeline aquifer. The northeastern part of the county is most susceptible to land-surface subsidence. From 1969-87, chloride concentrations differed by less than 15 mg/L. The median concentrations of dissolved solids were 475 mg/L in the upper unit of the Chicot, 337 mg/L in the lower unit, and 307 mg/L in the Evangeline. Between 1968-69 and 1987, water levels in wells in the upper unit of the Chicot generally fluctuated less than 4 ft and declined in wells in the lower unit of the Chicot from less than 10 ft in most of western Fort Bend County to 100 ft in the northeast. Hydrographs of wells completed in the lower unit of the Chicot showed that water levels continued to decline from 1969 to the early 1980's. The hydrographs of wells located outside of the northeast area generally show a stabilization of water levels after 1982, corresponding to the reductions in withdrawals in the county and neighboring Houston metropolitan area. Withdrawals from the Evangeline aquifer increased from 15% of the total withdrawals in 1969 to 50% in 1986. Water-level declines in wells screened in the Evangeline aquifer during 1969-86 ranged from less than 25 ft in northwestern Fort Bend County to 125 ft in the northeast. In the southwestern one-fourth of the county, decline was less than 50 ft. (USGS)
W91-04467

PRINCIPAL FACTS FOR GRAVITY STATIONS IN THE ELKO, STEPTOE VALLEY, COYOTE SPRING VALLEY, AND SHEEP RANGE AREAS, EASTERN AND SOUTHERN NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-04473

GROUND-WATER LEVELS IN WATER YEAR 1987 AND ESTIMATED GROUND-WATER PUMPAGE IN WATER YEARS 1986-87, CARSON VALLEY, DOUGLAS COUNTY, NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04474

DOCUMENTATION OF MODEL INPUT AND OUTPUT VALUES FOR THE GEOHYDROLOGY AND MATHEMATICAL SIMULATION OF THE PAJARO VALLEY AQUIFER SYSTEM, SANTA CRUZ AND MONTEREY COUNTIES, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
H. T. Mitten, and C. J. Longquist.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-196, 1990. 4p, 1 fig, 3 tab, 2 ref.

Descriptors: *California, *Geohydrology, *Groundwater, *Model studies, *Pajaro Valley, Aquifers, Monterey County, Santa Cruz County.

This report contains listings of the model input and sample output for simulation of the Pajaro Valley aquifer system, Santa Cruz and Monterey Counties, California. The files are contained on a 5 1/4-inch diskette. The decompressed files require approximately 5.3 megabytes of disk space on an IBM-compatible microcomputer. (USGS)
W91-04477

GROUND-WATER LEVELS IN THE ALLUVIAL AQUIFER IN EASTERN ARKANSAS, 1989.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04479

GROUNDWATER RESOURCES OF PIKE COUNTY, PENNSYLVANIA.
Geological Survey, Harrisburg, PA.
For primary bibliographic entry see Field 2F.
W91-04641

RECORDS OF WELLS AND CHEMICAL ANALYSES OF GROUND WATER IN DEUEL AND HAMLIN COUNTIES, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W91-04865

GROUND-WATER RESOURCES OF SELECTED HIGH VOLCANIC ISLANDS OF TRUK WITH EMPHASIS ON SMALL VILLAGE SUPPLIES.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04866

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 1990.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04870

SALT-DOME LOCATIONS IN THE GULF COASTAL PLAIN, SOUTH-CENTRAL UNITED STATES.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04880

WATER RESOURCES OF THE DESCANSO AREA, SAN DIEGO COUNTY, CALIFORNIA.
Geological Survey, San Diego, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04882

DIGITAL SIMULATION OF THE GLACIAL-AQUIFER SYSTEM IN THE NORTHERN THREE-FOURTHS OF BROWN COUNTY, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04884

GROUND-WATER PUMPAGE AND WATER-LEVEL DECLINES IN THE PEEDEE AND BLACK CREEK AQUIFERS IN ONSLOW AND JONES COUNTIES, NORTH CAROLINA, 1900-86.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04901

4C. Effects On Water Of Man's Non-Water Activities

LANDSAT TM STUDY OF AFFORESTATION IN NORTHERN SCOTLAND AND ITS IMPACT ON BREEDING BIRD POPULATIONS.
National Remote Sensing Centre, Farnborough (England).
For primary bibliographic entry see Field 7B.
W91-03948

PROPOSED MODEL FOR EVALUATING URBAN HYDROLOGIC CHANGE.
Washington Univ., Seattle. Dept. of Civil Engineering.
M. Wigmosta, and S. J. Burges.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 742-763, November/December 1990. 11 fig, 3 tab, 20 ref. USGS Award 14-08-0001-G1300.

Descriptors: *Evapotranspiration, *Land use, *Mathematical models, *Model studies, *Precipitation, *Urban hydrology, Flow rates, Overland flow, Saturation, Storm runoff, Storm seepage, Urban planning.

Evaluation of the effects of land-use change in a natural catchment and what can be done to mitigate these effects requires accurate quantitative representation of the mechanisms by which precipitation contributes to runoff in the natural and changed states. The locations of flow production zones must be predicted, how these zones change with time, and where flow from each zone enters the channel system. A model is presented that simulates flux rates and spatial distributions of evapotranspiration, Horton and saturated overland flow, subsurface storm flow, and dry-weather base flow. The model is operated continuously in time and has parameters that are readily measured or estimated, allowing land use changes (forest cover removal, regrading, litter zone removal) to be explicitly represented. The model is applied to a 39 ha ungauged catchment in King County, Washington, and an approximate calibration is achieved by comparing the location of simulated runoff production zones against field mapped locations. The model is used to explore the relative temporal and spatial effects of land use change on storm hydrographs, flow duration, and long term mass balance. A model structure permitting comparison of directly observable field states with comparable model predicted states is very useful. (Author's abstract)
W91-03990

ASSESSMENT OF RUNOFF AND SUSPENDED SEDIMENT YIELD IN A PARTIALLY FORESTED CATCHMENT IN SOUTHERN CHILE.
Universidad Austral de Chile, Valdivia. Inst. de Manajo Forestal.
A. Iroume.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2637-2642, November 1990. 6 fig, 2 tab, 31 ref.

Descriptors: *Environmental effects, *Erosion, *Forest hydrology, *Forestry, *Land use, *Rainfall-runoff relationships, *Runoff, *Soil erosion, Baseline studies, Chile, Forests, Precipitation rate, Rainfall, Sediment yield, Silviculture, Surface runoff, Suspended sediments.

Forestry-related activities are usually associated with accelerated erosion and increased soil deterioration and suspended loads in rivers. There is a lack of quantitative data concerning the potential impacts of silvicultural and land use changes on soils and rivers in southern Chile. The Faculty of Forest Sciences of Universidad Austral de Chile is studying an experimental watershed intended partly to provide data on the impact of silviculture and land use changes. A 12-month study of runoff and suspended sediment yield was undertaken in a 0.93 square km catchment in southern Chile. About 27% of the catchment was under natural forests, 33% was covered with radiata pine, planted between 1976 and 1982, and the remaining 40% was grassland. Rainfall for the period December 1983-November 1984 was estimated at 2170 mm and total runoff was 1150 mm, representing a runoff coefficient of 0.53. Suspended sediment concentrations ranged between 14 and 186 mg/L, with an average of 71 mg/L. Suspended sediment yield was estimated at 84 ton or 90 ton/square km/year. (Mertz-PTT)
W91-04118

USE OF DEPARTURE ANALYSIS IN DECISION MAKING.
National Park Service, Fort Collins, CO. Water Resources Div.
O. R. Williams, S. L. Ponce, and A. E. Johns.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 447-453, 17 ref.

Descriptors: *Decision making, *Land management, *Land use, *Water resources management, *Water use data, Case studies, National Park Service, Policy making, Resources management.

The effects of land management decisions upon other resource values are of increasing consequence as resources become more and more scarce. Land managers must be prepared to use the state of the science to make as nearly complete an analysis as is feasible to determine all resource impacts consequent to the implementation of a land management decision. A case study is presented to describe the 'Departure Analysis' methodology used by the National Park Service to make management evaluations of decisions effecting natural resources within units of the National Park Service, using Zion National Park as the example. The departure analysis began with a field inventory designed to identify park resources attributes which are related to or dependent upon either surface or subsurface sources of water. Along with the field effort, an extensive literature review was conducted which included historic documentation regarding park resources. The next step in the analysis was the simulation perturbation of existing hydrologic regimes. To accomplish this, standard hydrologic and engineering approaches were employed. Existing formulae and computer models were calibrated and verified with measured data and then supplies with input data that represent hypothetical alterations of historic flow. These simulated responses and their associated effects upon water related resource attributes were then compared to existing conditions as determined by field measurement and expert opinion. Changes from the existing condition can be associated with simulated changes in the hydrologic regime to indicate magnitudes of both the effect and the perturbation which caused it. By the same token, barometer responses can be identified which presage system responses in instances where hydrologic regime alterations have occurred or will occur. (See also W91-04161) (Lantz-PTT)
W91-04209

LAND CLEARANCE AND RIVER SALINISATION IN THE WESTERN MURRAY BASIN, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
G. B. Allison, P. G. Cook, S. R. Barnett, G. R. Walker, and I. D. Jolly.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 1-20, November 1990. 10 fig, 1 tab, 43 ref.

Descriptors: *Australia, *Groundwater recharge, *Land use, *Salinity, *Salinization, *Surface-groundwater relations, *Water pollution sources, Aquifers, Chlorides, Groundwater models, Land clearing, Mathematical models, Murray Basin, Prediction, River Murray, Semiarid lands, Vegetation effects, Water table.

The clearing of native vegetation in a semiarid region of southern Australia has led to increases in groundwater recharge of about two orders of magnitude. Although most of the clearing took place early in this century, the generally deep water table along with the low rates of recharge means that there is a considerable delay in the response of the aquifer to the increased recharge. The rates of pre-clearing and post-clearing recharge, and the time delay in aquifer response have been estimated using unsaturated zone chloride and matric suction profiles. Predictions of the time lag in aquifer response have been verified using bore hydrographs. The results of these analyses suggest that where the soils are light textured, and the water table is less than 40 m below the soil surface, it is now rising. Where the soils are heavier textured, it is estimated that the water table is rising only where it is less than 10 m below the soil surface. The effect of the increased recharge rates on the salinity of the River Murray, a major water resource, have been predicted using a groundwater model of the region. The predictions suggest that the salinity of the river will increase about 1 micro/cm/yr over the next 50 yr and beyond. (Author's abstract)
W91-04386

GROUNDWATER RESPONSE TO REFORESTATION IN THE DARLING RANGE OF WESTERN AUSTRALIA.
Water Authority of Western Australia, Perth.
R. W. Bell, N. J. Schofield, I. C. Loh, and M. A. Bari.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 179-200, November 1990. 9 fig, 2 tab, 26 ref.

Descriptors: *Australia, *Groundwater recharge, *Reforestation, *Saline water, *Soil-water-plant relationships, *Vegetation effects, *Water table rise, Darling Range, Groundwater level, Land use, Rainfall, Salinity, Surface-groundwater relations, Water table.

Replacement of deep-rooted perennial vegetation with annual crops and pastures has led to rising groundwater tables and transport of previously stored salts to streams in southwest Western Australia. Trials to determine the potential of various reforestation strategies to reverse this process by lowering the groundwater table were commenced at 1976-1981. Results are reported from six experimental sites for the period 1979-1986. Despite the fact that the mean annual rainfall of the experimental period was 10% below the 1926-1986 mean, groundwater levels under pasture rose by up to 1.2 m. The change in groundwater levels beneath reforestation ranged from a 0.6-m increase to a 3-m decrease relative to the ground surface. Groundwater levels under reforestation in all cases decreased relative to groundwater levels under pasture. The magnitude of this reduction increased with the proportion of cleared area reforested and with the crown cover of the reforestation. The salinity of the water table decreased by 12% under reforestation and by 32% under pasture over the period 1979-1986. (Author's abstract)
W91-04398

OPTIMIZATION OF INSECTICIDE TREATMENTS IN RIVERS: AN APPLICATION OF GRAPH THEORY FOR PLANNING A BLACK FLY LARVAE CONTROL PROGRAM.
Quebec Univ., Trois-Rivieres. Groupe de Recherche sur les Insectes.
A. Chalifour, J. Boisvert, and C. Back.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 2049-2056, October 1990. 2 fig, 2 tab, 23 ref.

Descriptors: *Black flies, *Insect control, *Insecticides, *Larvicides, *Mathematical models, *Rivers, Africa, Bacterial toxins, Economic aspects, Juvenile growth stage, Transport equation.

Combining a model of susceptibility of black fly larvae to commercial formulation of Bacillus thuringiensis var. israelensis and a one-dimensional transport equation in a river, the quantity of larvicide that should be applied at a given site in order to achieve a given mortality downstream can be calculated. The obtained relation, a function of biological and hydrological parameters, enabled the calculation of costs related to the treatment of a section of river. An optimal strategy of treatment

can be determined that minimizes the quantity of an insecticide applied and the logistic movement between injection sites. Optimal solution is found with the aid of an algorithm developed in operations research theory to solve this combinatorial problem. An experimental treatment conducted in the Onchocerciasis Control Program in West Africa is an example of the model's application to illustrate the savings of insecticide, time and money using this approach. (Author's abstract)
W91-04446

EFFECTS OF URBANIZATION ON PEAK STREAMFLOWS IN FOUR CONNECTICUT COMMUNITIES, 1980-84.
Geological Survey, Hartford, CT. Water Resources Div.
L. A. Weiss.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4167, 1990. 40p, 16 fig, 9 tab, 19 ref.

Descriptors: *Connecticut, *Mathematical models, *Peak flow, *Rainfall-runoff relationships, *Urban hydrology, *Urban runoff, Betts Pond Brook, Freshwater Brook, Glacial deposits, Harbor Brook, Keelers Brook, Piper Brook, Rainfall infiltration, Runoff simulation, Surface water, Willow Brook.

Ratios of peak flows in urban basins to peak flows in rural basins in Connecticut are about 1.5 to 6.1 for the 2-year flood and 1.1 to 4.3 for the 100-year flood. The lower ratios, in each case, apply where 30% of the area is served by storm sewers, and the higher ratios apply where 90% of the area is served by storm sewers. Peak flows for six small urban streams were determined from rainfall and runoff data collected from 1981 to 1984 and from a distributed-routing rainfall-runoff model that simulated storm runoff for the period 1951-80. Recurrence intervals of the peak flows for these streams and three other urban streams were estimated using the log-Pearson Type III method and compared with peak flows for rural streams that were computed from regression equations. A comparison of the ratios of urban to rural peak flows shows that basins where more than 50% of the area is served by storm sewers have urban to rural ratios that are outside the 95% confidence limits of the rural regression equations. Peak flows for such areas can be adjusted graphically for the effects of urbanization if the streams drain less than 10 sq mi and manmade storage is less than 4.5 million cu ft/sq mi. (USGS)
W91-04464

HYDRAULIC CHARACTERISTICS OF FOUR PEATLANDS IN MINNESOTA.
Ruppin Inst., Emek Hefer (Israel).
For primary bibliographic entry see Field 2H.
W91-04553

STAR FIRE MINE RECLAMATION EXPERIENCE.
Kentucky Univ., Lexington. Dept. of Horticulture and Landscape Architecture.
T. J. Nieman, and D. Meshako.
Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 5, p 529-532, September/October 1990. 3 fig, 2 ref.

Descriptors: *Coal mining effects, *Community development, *Kentucky, *Land management, *Land reclamation, *Strip mines, Aesthetics, Artificial lakes, Environmental engineering, Fish stocking, Geese, Land development, Land use, Long-term planning, Management planning, Resources development, Short-term planning, Soil management, Strip mine lakes, Vegetation establishment.

Planning for higher and better post-mining use in the coal-producing region of eastern Kentucky will not only benefit the mine owner but enhance community development. The 1977 Surface Mining Control and Reclamation Act was instrumental toward helping resolve the environmental and aesthetic problems associated with surface mining; however, coal operators were not anxious to reclaim the land, because if mining technology were to advance or if the price of coal were to rise, remining could occur. Leasing of subsurface mineral rights is another issue that exacerbates the reclamation situation. The present Star Fire mine in Kentucky has no lease holdings, so it is in the owner's best interest to reclaim the site in a way that creates a post-mining land value. Star Fire is now being mined using the mountaintop removal/valley fill process, creating more than 5,000 acres of flood-free, potentially-developable, gently rolling hills by the end of the mining operation. Research was initiated into the development of a planning model and a long-term comprehensive land use plan based on a regional needs assessment. One short-term goal has been reached thus far: a 35-acre lake to be used as a Canada goose refuge has been constructed on top of unconsolidated mine spoils, and the lake has successfully been revegetated, and stocked with geese and fish. The long-term plan includes opportunities for economic diversification and the development of land forms that will best accommodate these opportunities. As scenarios, including industrial and residential development, agriculture, and wildlife habitat, as well as the supporting infrastructure and amenities, are proposed, the land forms that best suit the land uses will be investigated and modeled. (Fish-PTT)
W91-04562

STATE-OF-THE-ART TIMBER HARVEST IN AN ARIZONA MIXED CONIFER FOREST HAS MINIMAL EFFECT ON OVERLAND FLOW AND EROSION.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
B. H. Heede, and R. M. King.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 623-635, December 1990. 4 fig, 2 tab, 21 ref.

Descriptors: *Arizona, *Coniferous forests, *Erosion rates, *Forest management, *Logging, *Overland flow, *Rainfall-runoff relationships, *Sediment discharge, *Soil erosion, Erosion control, Lumber industry, Peak flow, Sedimentation, Surface flow.

When the Thomas Creek, Arizona watershed was logged for the first time, the latest state-of-the-art harvesting was applied. Trees were cut in patches and by group selection, and logs skidded by crawler tractor. Although overland flow and sediment delivery, measured on small sub-drainages of the watershed, were inconsequential, sediment deliveries from severely disturbed areas and undisturbed forest floor were significantly different (41 kg/hectare/year for disturbed areas and 6 kg/hectare/year for undisturbed areas). The highest erosion rates (128 kg/hectare/year) were created by monitoring activities which entailed the use of over-snow vehicles and trail bikes. Nearly instantaneous rises in the hydrograph at the start of storms were caused by pipe flows. Significant increases of flow volumes and peak flows after timber harvest increased magnitudes of channel adjustment processes (erosion) that had existed already before logging. This development was judged positively, because it suggests more rapid attainment of a new dynamic equilibrium. The study demonstrated that mixed conifer forests can be harvested without detrimental effects on the watershed if state-of-the art techniques are used. (Author's abstract)
W91-04803

4D. Watershed Protection

FINITE ELEMENT WATERSHED MODELING: ONE-DIMENSIONAL ELEMENTS.
Michigan State Univ., East Lansing. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W91-03993

SURFACE WATER MANAGEMENT FOR CROP PRODUCTION ON HIGHLY ERODIBLE LAND.
North Carolina State Univ., Raleigh.
G. C. Naderman, J. R. Hansard, and H. P. Denton.
Applied Agricultural Research AAREEZ, Vol. 5, No. 4, p 243-254, Fall 1990. 1 fig, 2 tab, 42 ref.

Descriptors: *Agricultural engineering, *Crop production, *Erodibility, *Erosion control, *Surface water, *Water conservation, *Water management, Cropland, Economic evaluation, Farming, Soil conservation, Soil erosion, Soil management, Tillage.

Management of surface water has four broad objectives: (1) appropriate removal of excess water during wet periods, (2) water conservation for crop use, (3) on-site erosion control to protect long-term soil productivity and reduce short-term damages, and (4) off-site damage prevention from sedimentation and water pollution. For production of crops on erodible land, the importance of water conservation to enhance yield and potential profits must be emphasized. Economic studies conclude that structural approaches to control on-site erosion, such as terraces, diversions, sediment basins, sod waterways, and field borders, are seldom profitable in terms of protecting soil productivity. Cultural approaches include contour farming, crop rotation, stripcropping, and conservation tillage. Applications of these concepts in the southeastern U.S. show that the use of a tillage and cropping system designed for erosion protection is economically more attractive than structures especially if the cropping system does not greatly reduce the total value of farm products sold. In contrast to the on-site losses, annual costs of off-site damages from cropland erosion and runoff are probably 10 to 55 times as great. Grain crop production on highly erodible land continues to be difficult and risky. Whether farmers can achieve this profitably, and with conservation compliance as defined by the 1985 Food Security Act, will greatly depend upon the alternative types of land available and the extent of conservation treatment required. (Author's abstract)
W91-04539

EFFECTS OF POTATO CROPPING PRACTICES ON WATER RUNOFF AND SOIL EROSION.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
For primary bibliographic entry see Field 2J.
W91-04552

NEW STRATEGIES FOR SOIL CONSERVATION.
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
D. W. Sanders.
Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 5, p 511-516, September/October 1990. 3 fig, 11 ref.

Descriptors: *Agricultural practices, *Environmental policy, *Erosion control, *Land management, *Land resources, *Land use, *Policy making, *Resources management, *Soil conservation, Farm management, Future planning, Government supports, Planning, Public participation, Rural areas, Social aspects, Soil erosion.

Traditional land conservation systems have elicited great interest of late, and a number of studies have been conducted recently to find out more about them and to see if they can be adapted to present-day conditions. However, many of the ancient systems are breaking down or being abandoned. Before new policies and strategies for soil conservation programs can be developed based on traditional systems, the extent to which factors leading to the abandonment of the old systems are related to those restricting the use of modern systems, and social structures of today which may be responsible for these effects, must be understood. The practical application of modern-day soil conservation began on a large scale in the 1930s, and generally involves a three-step approach: identification of the problem, planning control measures, and implementation of the plan. Problems with this approach include emphasis on physical conservation measures (symptoms) instead of on incorrect

land use (problem), and lack of attention to future needs of farmers. New policies and strategies can be effective only if they aim to achieve conservation through a more effective approach--one that will ensure the large-scale participation of rural people in conservation--by identifying the causes of land degradation, involving the farmer, and selecting the right technologies. A framework for implementation must include improving land use, encouraging the participation of land users, developing institutions and an advisory committee, strengthening government services, preparing a sound legal base, manpower and training, identifying research needs, and developing conservation programs at national, district, and local levels. (Fish-PTT)
W91-04561

STATE-OF-THE-ART TIMBER HARVEST IN AN ARIZONA MIXED CONIFER FOREST HAS MINIMAL EFFECT ON OVERLAND FLOW AND EROSION.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 4C.
W91-04803

EROSION AND SEDIMENT CONTROL, THE MARYLAND WAY.
Maryland State Highway Administration, Baltimore.
E. G. Stein.
Public Works PUWOAH, Vol. 121, No. 13, p 54-56, December 1990.

Descriptors: *Erosion, *Erosion control, *Maryland, *Sedimentation, Grading, Highway effects, Regulations, Slopes, Soil stabilization, Surface runoff.

Before 1984 the Maryland State Highway Administration (SHA) did not give a high priority to controlling sediment runoff during highway construction. In 1984 several changes were occurring that dictated modifying the way SHA approached controlling sediment runoff and erosion during construction. The overall concept for erosion and sediment control can be broken down into three major elements. The first and most obvious element is installing perimeter controls before grubbing begins. After these controls are established, the actual grading operation commences with excavation of sediment basins during construction and stormwater management ponds once the construction is completed and all disturbed areas are stabilized. The second major element is to provide flexibility in the plan to address changing field conditions and problem areas not identified during project design. The third major element addresses the construction of major water crossings, which require a 'Waterway Construction Permit' for any stream crossing having a drainage area of 400 acres or better. Disturbance is further limited by not allowing a contractor to grade a unit greater than 20 acres at any one time. Early stabilization of exposed soils is one of the most effective controls available. Once the grading operation is completed, and in areas of temporary work stoppages where slopes are steeper than 3:1, stabilization must be completed within seven calendar days. In addition, the controls are inspected during and immediately after every storm event. Although these controls have resulted in an average increase of 7.5% in construction costs, water quality in Chesapeake Bay has improved and populations of rock fish and channel crabs have increased since the control were implemented. (White-Reimer-PTT)
W91-04852

DECISION SUPPORT FOR BEST MANAGEMENT PRACTICE SELECTION.
Purdue Univ., Lafayette, IN. Water Resources Research Center.
For primary bibliographic entry see Field 6A.
W91-04905

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

TOTAL PARAMETER WATER ANALYSIS COMES UNDER THE MICROSCOPE.
R. Green.
Water & Waste Treatment Journal WWTJAA, Vol. 32, No. 5, p. 30, May 1989. 2 fig.

Descriptors: *Chemical analysis, *Measuring instruments, *Monitoring, *Organic carbon, *Pollutant identification, *Water analysis, Analytical techniques, Autoanalyzers, Automation, Dissolved organic carbon, Total organic carbon.

Practical instruments for automatic and semi-automatic measuring and recording of water pollution levels are available which will reliably sample, condition, and measure TOC (total organic carbon), TIC (total inorganic carbon), and DOC (dissolved organic carbon). In a typical example of such 'total parameter' devices, filtered water is dripped into a very hot reactor. The carbon contained in the sample is burned to carbon dioxide with atmospheric oxygen. After separating the water, the gas stream enters an infrared gas analyzer whose indicated carbon dioxide value is directly proportional to the TOC value. More highly-automated versions of this type of analyzer also exist. These allow the performance of many additional functions--periodic checking with zero and with a calibration solution, automatic switching of measuring ranges, filtration for sample conditioning, or recording of the TOC value with a line recorder. Other equipment is available, including sample sequencers, automatic acidification, and parallel or successive measurement of TOC and TIC. A different measuring principle is generally employed for the determination of DOC. It does not use the thermal process for converting the carbon in the water sample into carbon dioxide, but rather a photochemical process, using an ultraviolet lamp of very short wavelength radiation. These types of instruments are of particular benefit to water pollution monitoring organizations, which will always welcome faster throughput and increased accuracy. (Doyle-PTT)
W91-03970

MEASURING ALUMINUM DURING WATER TREATMENT: METHODOLOGY AND APPLICATION.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-03976

REAL-TIME SAMPLING STRATEGIES FOR ESTIMATING NUTRIENT LOADINGS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. H. Burn.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 727-741, November/December 1990. 2 fig, 1 tab, 8 ref.

Descriptors: *Freshwater, *Nutrient transport, *Pollutant identification, *Sampling, *Water analysis, *Water pollution, *Water quality, *Water sampling, Decision making, Mathematical models, Precision, River flow, Streamflow.

The estimation of nutrient or pollutant loading in rivers is a problem in efficiency. Reliable estimates are required to make optimal decisions using collected data, while still considering cost minimization. An investigation of water quality sampling strategies applicable to real time sampling programs are presented, designed to be a component of the data collection process for the determination of the annual mass load of pollutants, or nutrients, in a river. The sampling schemes are intended for use in situations where stream flow data are collected regularly, but concentration data are collected during only a limited number of time periods. The sampling strategies are evaluated through the use of a Monte Carlo experiment that created synthetic stream flow and associated nutrient concentration data. The performance of each sampling strategy is evaluated and compared in terms of an accuracy measure and a precision measure to establish the relative merits of the proposed schemes. A sampling scheme incorporating stratified sampling with real-time updating of the sampling characteristics is found to give the best estimate of the annual mass load. (Author's abstract)
W91-03989

DEVELOPMENT OF AN ESTUARINE SEDIMENT BURROWING BIOASSAY FOR SHIPBOARD USE.
District of Columbia Univ., Washington. Dept. of Biology.
H. L. Phelps.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 722-728, November 1990. 3 tab, 14 ref.

Descriptors: *Analytical methods, *Animal behavior, *Bioassay, *Clams, *Estuarine sediments, *Pollutant identification, *Toxicity, Copper, Field tests, Marine pollution, Salinity, Sediment contamination, Water pollution effects.

Estuarine sediments, particularly muds, are accumulators of pollutants. A rapid estuarine sediment bioassay based on the burrowing speed of a soft-shell clam, Mya arenaria, was extensively tested in the laboratory. This bioassay on shipboard might be useful in determining sites with in situ toxicity where additional synoptic sampling should be made for biological and chemical components of the Sediment Quality Triad, such as community structure and chemical contaminants. The bioassay is conducted by placing 20 clams on a one liter sediment sample in a plastic box with 13.5 sq cm surface area and 5 cm of water, noting the number of clams completely burrowed at increasing intervals, and calculating the estimated time for 50% of clams to burrow (ET50) by Logit analysis. A sediment was considered significantly different if the bioassay ET50 95% F.L. exceeded the simultaneous control sediment bioassay ET50 95% F. L. Laboratory comparison of clam burrowing speeds in different sediment types showed no significant difference between fine sand, coarse sand, and muddy sand, and only marginally slower speed in mud sediment. Laboratory bioassays with different sediment salinities found slight but significant increase in burrowing speed only at 32 ppt sediment salinity. When the collected cruise sediment samples were re-tested in the laboratory with overlaid water at 13 ppt, 11 out of 39 sediments (28%) showed significant inhibition of clam burrowing speed. Copper spiking of marine sediment found clam burrowing inhibition related only to changes in sediment pore-water copper, not total sorbed copper. All of the retested sediment samples showed loss of burrowing inhibition by the third day of testing (fifth day post-cruise). The post-cruise testing showed the importance of conducting the bioassay within five days of sediment collection. The clam burrowing bioassay is compact and can be used on shipboard to rapidly screen euryhaline sediments collected during a cruise, indicating the immediate need for more sampling to determine the cause of the burrowing inhibition. As estuarine conditions greatly affect chemical bioavailability, this bioassay would be helpful in determining the conditions of significant toxicant release from sediment. (Brunone-PTT)
W91-04017

CRAYFISH AS A 'BIOLOGICAL INDICATOR' OF AQUATIC CONTAMINATION BY HEAVY METALS.
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
M. A. Alikhan, G. Bagatto, and S. Zia.
Water Research WATRAG, Vol. 24, No. 9, p 1069-1076, September 1990. 5 fig, 5 tab, 43 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Crayfish, *Heavy metals, Cadmium, Copper, Gills, Industrial water, Iron, Lake sediments,

Lakes, Magnesium, Manganese, Nickel, Smelters, Tissue analysis, Water pollution effects, Water pollution sources.

Cu, Cd, Mg, Mn and Ni concentrations in whole crayfish, Cambarus bartoni, trapped from Nepahwin Lake, Joe Lake and Wizard Lake, lying at distances of 10, 30, and 150 km, respectively, from the Sudbury smelters in Northeastern Ontario, showed an inverse relationship with the distance of the habitat from the emission site. Highest concentrations of Cu were observed in the hepatopancreas, Cd in the hepatopancreas and the gut, Fe and Mn in the gut, and Mg in the exoskeleton. Tissue concentrations of Ni and Zn were highly variable. Differences between males and females at each sampling site were not significant at the 5% level. The general relationship between crayfish tissue metal concentrations at the three sites was Cu > Mg > Mn > Zn > Ni > Cd. This observed relationship, except for Mg and Mn, agreed with the concentration relationship of these metals in the water and the sediments (top 10-20 cm) in the three lakes. In laboratory studies, Cu concentrations in the hepatopancreas, gills, exoskeleton and the viscera increased significantly over the control during the 4-weeks exposure to 125, 250 and 500 micrograms Cu/L. Hepatopancreas, in general, had the highest Cu concentration, and the exoskeleton, the lowest. Relationship between Ni exposure and the tissue Ni concentrations in the four treatments was 800 micrograms Ni/L > 400 micrograms Ni/L = 200 micrograms Ni/L > control, while between the exposure periods and the tissue Ni concentrations was week 4 > week 1 > week 3 = week 2. Highest Ni concentrations at the end of the 4-week exposure to Ni were observed in the gut, gills and the hepatopancreas, and the lowest in the viscera. The present study suggests that Cambarus bartoni is a reliable indicator of the presence of class B and borderline elements with specific gravity > 5 in the aquatic environment. However, their value as biomonitors of variations in Cu and Ni concentrations in freshwater ecosystems is debatable. (Author's abstract)
W91-04035

OZONATION OF PYRENE IN AQUEOUS SOLUTION.
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
For primary bibliographic entry see Field 5F.
W91-04041

RESIN CONCENTRATION OF BY-PRODUCTS FROM CHLORINATION OF AQUATIC HUMIC SUBSTANCES.
Ecole Nationale Superieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Genie de l'Environnement.
For primary bibliographic entry see Field 5F.
W91-04046

TRACE NUTRIENT DEFICIENCY IN DAPHNIA MAGNA CULTURED IN STANDARD MEDIUM FOR TOXICITY TESTING: EFFECTS OF THE OPTIMIZATION OF CULTURE CONDITIONS ON LIFE HISTORY PARAMETERS OF D. MAGNA.
Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.
B. P. Elendt, and W. R. Bias.
Water Research WATRAG, Vol. 24, No. 9, p 1157-1167, September 1990. 1 fig, 9 tab, 42 ref. Federal Environmental Agency, Research and Development Project 106-03-072.

Descriptors: *Bioindicators, *Culturing techniques, *Daphnia, *Growth media, *Laboratory methods, *Nutrients, *Selenium, *Toxicity, Growth, Testing procedures, Trace levels.

The suitability of various synthetic media for the culture of Daphnia magna was tested. Daphnids cultured in a standard medium for toxicity testing proposed by ISO showed low reproduction, reduced growth, high number of undeveloped parthenogentic eggs and high mortality of neonates and adults. Animals cultured in the ISO medium lost parts of their second antennae due to selenium deficiency. The addition of selenium to the ISO medium clearly improved the quality of this medium. However, results of several tests were more variable than when a medium with a complex trace element composition (medium M4) was used. Medium M4 has allowed continuous culture of daphnids for three years without any signs of reduced viability or reproduction. A mean reproduction rate of about 140 progeny/parent daphnid was calculated from 19 nonsimultaneous experiments. Neither a fourfold increase nor a reduction to one tenth of the trace element concentration of M4 had any effect on reproduction, growth or survival of daphnids. Since ion-exchanger cartridges can leach detrimental substances into the matrix water, only ultrapure matrix waters should be used for the preparation of culture media. (Author's abstract)
W91-04047

INFLUENCE OF WATER COMPOSITION ON THE CHRONIC TOXICITY OF 3,4-DICHLOROANILINE TO DAPHNIA MAGNA.
Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.
For primary bibliographic entry see Field 5C.
W91-04048

TOTAL ORGANIC HALOGENS (TOX) ANALYSIS IN ETHER SOLUTIONS.
Ecole Nationale Superieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Genie de l'Environnement.
P. LeCloirec, R. M. Lelacheur, J. D. Johnson, and R. F. Christman.
Water Research WATRAG, Vol. 24, No. 9, p 1173-1176, September 1990. 1 fig, 3 tab, 12 ref. NSF Grant CEE 83-12997.

Descriptors: *Halogenated compounds, *Organic compounds, *Pollutant identification, *Water analysis, Activated carbon, Adsorption, Chlorinated hydrocarbons, Pyrolysis.

A new procedure to determine total organic halogens (TOX) recovered in ether extracts was developed as a modification of the EPA standard method for TOX analysis in aqueous solutions. A volume of sample was injected directly into the activated carbon in the pyrolysis furnace sample boat. Good recoveries (80-100%) were found for all the model compound solutions, except for the n-chloroalkanes. In this case, the molecules are long chain aliphatics and were not easily pyrolyzed in the furnace. A linear correlation was found between the percentage recovery of these aliphatic compounds and the number of carbons in the molecule. The precision of the method was found to be 2-3% for TOX in the 1,000-100,000 nanogram injected range. (Author's abstract)
W91-04049

IMPROVED MEMBRANE FILTRATION METHOD INCORPORATING CATALASE AND SODIUM PYRUVATE FOR DETECTION OF CHLORINE-STRESSED COLIFORM BACTERIA.
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
J. P. Calabrese, and G. K. Bissonnette.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3558-3564, November 1990. 2 fig, 4 tab, 45 ref.

Descriptors: *Bioindicators, *Coliforms, *Microbiological studies, *Pollutant identification, *Selective media, *Water analysis, Chlorination, Disinfection, Escherichia coli, Fecal coliforms, Laboratory methods, Water quality, Water treatment.

Chlorination is the most widely used method in the United State for disinfection of potable waters and municipal sewage discharges. It is well recognized that coliforms subjected to chlorine may become stressed, resulting in a reduced ability of these injured bacteria to proliferate on selective media employed from their detection. Failure to detect coliforms can lead to an overly optimistic estimate of the safety of a water. In vitro pure culture studies were conducted on three different strains of Escherichia coli to determine the effect of chlorination on catalase activity. In each case, stationary-phase cells exhibited significant reductions in enzyme activity following exposure to chlorine. Mean differences in activity between control and chlorine-stressed cells varied, depending on E. coli strain. Following initial enzyme studies, resuscitation experiments utilizing the membrane filtration technique were conducted on chlorinated sewage effluent. Five different amendments, including catalase, heat-inactivated catalase, sodium pyruvate, and catalase-sodium pyruvate combination, and acetic acid, were tested for their ability to enhance the detection of chlorine-stressed cells on different media. Significant increases in recovery of fecal coliforms on M-fecal coliform (M-FC) media, total coliforms on mT7 and M-Endo media, and total heterotrophs on TGY media were obtained on plates containing catalase, pyruvate, or the combination of these compounds. Supplementation with heat-inactivated catalase and acetic acid did not improve recovery of chlorine-stressed cells compared with recovery on nonamended media. Subsequent analysis of colonies from plates containing compounds which enhanced recovery indicated coliform verification percentages of > 80% on M-FC media, > 90% on mT7 media, and > 94% on M-Endo media. These data suggest that the addition of peroxide-degrading compound to various standard recovery media may improve the detection of both coliform and heterotrophic bacteria in chlorinated waters. (Mertz-PTT)
W91-04067

DISTRIBUTION OF MYCOBACTERIA IN DIFFERENT TYPES OF WATER IN ISRAEL.
Hadassah Medical School, Jerusalem (Israel). Dept. of Environmental Health.
For primary bibliographic entry see Field 5B.
W91-04077

IDENTIFICATION OF THE DERIVATIVES OF C.I. REACTIVE BLUE 19 IN TEXTILE WASTEWATER.
Georgia Inst. of Tech., Atlanta.
S. R. Camp, and P. E. Sturrock.
Water Research WATRAG, Vol. 24, No. 10, p 1275-1278, October 1990. 3 fig, 8 ref. EPA and Georgia Tech Research Corporation cooperative agreement CR-814618-01-0.

Descriptors: *Chemical analysis, *Dyes, *Pollutant identification, *Textile mill wastes, *Water analysis, High performance liquid chromatography, Organic compounds, Vinyl sulfone.

Reactive dyes are becoming more popular in the textile manufacturing industry. The biggest problem with reactive dyes, however, is the competition between the reaction of the dye with the textile substrate and the reaction of the dye with water. Presently, fixation rates can vary from 60 to 90%, leaving large concentrations of unfixed dyes in the wastewater. Unfortunately, most commonly used wastewater treatment procedures do not remove these dyestuffs sufficiently. An analytical procedure was developed using a swept-potential electrochemical detector and high performance liquid chromatography for the separation and identification of the hydroxy and vinyl sulfone derivatives of Reactive Blue 19 in textile wastewater. The concentration of the vinyl sulfone in the textile mill effluent was estimated to be 760 ppb by comparison to the standard curve. The concentration of the hydroxylate was estimated to be 80 ppb. The three-dimensional data from the instrument provides an extra parameter (potential), which permits easier and more accurate identification. It was determined that the vinyl sulfone form of the dye was the predominant derivative in the wastewater sample. (Mertz-PTT)
W91-04083

JACKNIFE AND BOOTSTRAP ESTIMATION OF BIOLOGICAL INDEX OF WATER QUALITY.
Museo Nacional de Ciencias Naturales, Madrid (Spain).
A. G. Valdecasas, and A. Baltanas.
Water Research WATRAG, Vol. 24, No. 10, p

1279-1283, October 1990. 2 fig, 2 tab, 17 ref. CAICYT Grant no. PR84-0181.

Descriptors: *Biological index, *Pollution index, *Statistical analysis, *Statistical methods, *Water analysis, *Water quality, Bootstrap method, Jacknife method.

Many biological indices of water quality are generally used with a very low number of field samples to estimate water conditions. This precludes the application of traditional statistical techniques in order to test for significant differences between values of the indices for different sampling stations. Two non-standard statistical methods now in common use, namely the jacknife and the bootstrap, could be proficiently applied to obtain a quantitative measure of the indicator power of biological indices. Species in the saprobic system (initiated in 1902) are classified by their saprobic values. The saprobic value is obtained empirically by observing in nature the kind of water in which a species does best. A numerical index has been previously proposed that summarizes the array of species' saprobities obtained at each sampling station. This index has gained popularity since its proposal, especially through the diffusion given by general water treatises. In this index, saprobic values are fixed, but in more complex systems a certain variability is taken into account before obtaining the final value of saprobity for a sampling station. Using the jacknife estimation method, five mean values of the Pantle and Buck index, and their respective confidence limits, were obtained from the observed sample. No significant differences were obtained among the means of the different stations. The bootstrap estimation method provided a distribution of 1000 values of indices for each sampling station. As occurred with jacknife analysis, no differences were observed among the sampling stations. (Mertz-PTT)
W91-04084

ISOLATION AND PRECONCENTRATION OF VOLATILE ORGANIC COMPOUNDS FROM WATER.
Gdansk Technical Univ. (Poland). Inst. of Inorganic Chemistry and Technology.
J. Namiesnik, T. Gorecki, and M. Biziuk.
Analytica Chimica Acta ACACAM, Vol. 237, No. 1, p 1-60, October 1990. 26 fig, 7 tab, 695 ref.

Descriptors: *Analytical methods, *Gas chromatography, *Pollutant identification, *Sample preparation, *Volatile organic compounds, *Water analysis, Adsorption, Extraction, Literature review, Membranes, Organic compounds, Preconcentration, Trace levels.

Methods for the isolation and/or concentration of volatile organic compounds from water samples for trace organic analysis by gas chromatography are reviewed. The liquid-liquid extraction (LLE) method utilizes partitioning of toxic compounds into a suitable organic solvent from an aqueous mixture. As part of its master scheme for the analysis of 114 organic priority pollutants, the EPA has proposed a number of methods utilizing LLE as the first step in the analytical procedure. Another method of enrichment of trace organic compounds is adsorption on solid materials, which have high specific surface area, an ability to adsorb a wide variety of organic compounds from large volumes of water, and are chemically inert. A third group of methods for the extraction of organic compounds from an aqueous phase utilizes a gaseous phase. These methods comprise the gas stripping and static and dynamic headspace techniques. Permeation through membranes made of suitable hydrophobic materials is a fourth approach used for the isolation of volatile organic compounds from the aqueous phase. Some volume reduction methods for preparing organic concentrates include freeze concentration, freeze drying, vacuum evaporation, reverse osmosis, and ultrafiltration. Trace organic analysis by gas chromatography often requires an additional stage of preconcentration. The selection of the sampling procedure and subsequent introduction of the analytes into a gas chromatograph depend on various factors, such as the physicochemical characteristics of the trapping medium and the thermal lability and volatility of the analytes. (MacKeen-PTT)
W91-04139

LEAD HYDRIDE GENERATION IN A LACTIC ACID-POTASSIUM DICHROMATE MEDIUM AND ITS APPLICATION TO THE DETERMINATION OF LEAD IN FISH, VEGETABLE AND DRINK SAMPLES.
Universidad Complutense de Madrid (Spain). Dept. de Quimica Industrial.
Y. Madrid, J. Meseguer, M. Bonilla, and C. Camara.
Analytica Chimica Acta ACACAM, Vol. 237, No. 1, p 181-187, October 1990. 4 fig, 2 tab, 14 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Lead, *Pollutant identification, *Water analysis, Drinking water, Fish, Hydride generation, Precision, Sample preparation, Sensitivity, Trace levels.

The effect of different acids on the efficiency of lead hydride generation in potassium dichromate oxidant medium was investigated and lactic acid-potassium dichromate was found to give optimum lead hydride generation. Various parameters affecting sensitivity and the influence of interfering ions were studied. The sensitivity of the method (0.44 ng) is greater than published values for ammonium peroxodisulfate-nitric acid (20.0 ng) and hydrogen peroxide-nitric acid (10.0 ng) media. This may be due to lactic acid stabilizing the Pb(IV) metastable compounds more effectively, acting as intermediate species in lead hydride formation. The method was applied to the determination of lead in liquids (tap water and wine) and fish and vegetable samples. The liquids were analyzed directly without preconcentration or mineralization and the solids after wet digestion or slurry formation; these two sample preparation methods gave similar results. The precision of the method was 5.1% (mean of 10 values between batches) for 25 ng of lead. The detection limits were 0.04 and 0.10 microg/g for fish and vegetable samples, respectively. In liquids the detection limits were 0.005 and 0.02 microg/ml for tap water and wine, respectively. The method involves less sample handling with a consequent smaller risk of sample contamination. (MacKeen-PTT)
W91-04140

ANAEROBIC MICROBIAL DEGRADATION OF ACRIDINE AND THE APPLICATION OF REMOTE FIBER SPECTROSCOPY TO MONITOR THE TRANSFORMATION PROCESS.
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W91-04142

EVALUATION OF SUCROSE AS AN ALTERNATIVE TO SODIUM CHLORIDE IN THE MICROTOX ASSAY: COMPARISON TO FISH AND CLADOCERAN TESTS WITH FRESHWATER EFFLUENTS.
Environmental Research Lab.-Duluth, MN.
G. T. Ankley, G. S. Peterson, J. R. Amato, and J. J. Jenson.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1305-1310, 1990. 2 tab, 16 ref.

Descriptors: *Aquatic animals, *Effluents, *Fathead minnows, *In vitro tests, *Microtox assay, *Pollutant identification, *Toxicity, *Toxicology, *Water pollution effects, *Waterfleas, Acute toxicity, Analytical methods, Freshwater, In vivo tests, Toxicity tests.

The toxicity of 44 freshwater effluents was evaluated using the fathead minnow (Pimephales promelas), a cladoceran (Ceriodaphnia dubia) and Microtox (Photobacterium phosphoreum). The Microtox assay was conducted in both sodium chloride and sucrose for osmotic protection of the bacteria in an effort to determine whether the use of sucrose increased the sensitivity of Microtox to samples exhibiting toxicity to the fish and cladoceran species. Twenty-three of the effluents tested were toxic to fathead minnows and/or C. dubia; of these, Microtox was sensitive to 10 when tested in NaCl and seven when tested in sucrose. In one instance testing in sucrose predicted toxicity to the fish and cladoceran species when testing in NaCl did not. Single chemical tests demonstrated that Microtox sensitivity was greater to zinc chloride, nickel chloride and methanol when tested in sucrose as opposed to NaCl, about equal to copper sulfate and phenol in sucrose and NaCl, and was far greater to chlorine when tested in NaCl than in sucrose. These results, as well as data from Microtox assays with effluents containing known toxicants, suggest that the use of sucrose, in conjunction with NaCl, for osmotic adjustment in the assay could be helpful as part of a suite of tests for identifying general classes of compounds responsible for toxicity in freshwater effluents. (Author's abstract)
W91-04151

CHARACTERISTICS OF SURFACTANTS IN TOXICITY IDENTIFICATION EVALUATIONS.
Environmental Research Lab., Duluth, MN.
G. T. Ankley, G. S. Peterson, M. T. Lukasewycz, and D. A. Jensen.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 3-12, 1990. 5 tab, 15 ref.

Descriptors: *Aeration, *Filtration, *Pollutant identification, *Surfactants, *Toxicity, *Wastewater analysis, *Water analysis, Analytical methods, Analytical techniques, EPA methods, Effluent limitations, Effluents, Experimental design, Lethal limit, Particulate matter, Permits, Toxicity identification evaluation, Water quality standards.

Recent developments have enabled the incorporation of toxicity limits into permits for point-source dischargers in the United Sates. Therefore, it became necessary to develop methods that would enable dischargers to identify specific compounds responsible for toxicity in their effluents. A series of experiments were conducted to study the behavior of a number of anionic, nonionic and cationic surfactants in manipulations associated with toxicity identification evaluations (TIEs). The results of the experiments indicated that, regardless of class (i.e., anionic, nonionic, cationic), surfactants are likely to be removed, at least to some extent, from effluent samples by aeration. It was also found that toxicity due to surfactants can be reduced by filtering effluent samples, and the amount of toxicity lost upon filtration almost certainly depends upon particulate concentration in the sample. Finally, it was determined that C18 solid phase extraction (SPE) is extremely efficient at removing surfactant-associated toxicity from aqueous samples. However, for cationic classes of surfactants it may not be possible to recover them from the column with methanol/water elutions. Overall, if a test effluent displays several, or all, of the above characteristics in a TIE, this is a strong basis for suspecting that surfactants may be contributing to toxicity. Unfortunately, surfactants can be difficult to deal with analytically because it is not possible to fractionate, identify or quantify them using techniques suitable for nonpolar organics such as pesticides (e.g., gas chromatography/mass spectroscopy). However, knowledge of the type of discharge being subjected to the TIE may enable one to target specific surfactants, or classes of surfactants, for analysis. (Korn-PTT)
W91-04246

QUANTIFICATION OF TOXAPHENE RESIDUES IN FISH AND FISH PRODUCTS USING A NEW ANALYTICAL STANDARD.
Gesamthochschule Kassel (Germany, F.R.). Dept. of Analytical Chemistry.
G. Lach, and H. Parlar.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 29-34, 1990. 1 fig, 2 tab, 22 ref.

Descriptors: *Analytical techniques, *Chlorinated hydrocarbons, *Fish, *Gas chromatography, *Mass spectrometry, *Pesticide residues, *Pollutant identification, *Toxaphenes, Environmental samples, Insecticides, Negative ion mass spectrometry, Polychlorinated bornanes, Selected Ion Monitoring, Standards.

Toxaphene, the most heavily used chlorinated hydrocarbon insecticide, is difficult to quantify, because it is a mixture of more than 200 compounds, primarily polychlorinated bornanes. These components elute over a wide range of GC retention times and are not completely resolvable even by capillary columns. This is further complicated by interference with other organochlorine contaminants, some of which can be eliminated by adsorption column chromatography. Unfortunately, any additional clean-up procedures reduce recoveries, cause poor reproducibility and thus, compromise accuracy and sensitivity. Although selectivity can be achieved by use of negative ion mass spectrometry-selected ion monitoring (NICI-SIM), the GC analyses of environmental samples are furthermore complicated by changes in the original composition of the chlorobornanes due to chemical and metabolic conversions. Differences in the degree of chlorination or in positional isomerization influence NICI-SIM response significantly. Quantification using a technical standard can therefore lead to erroneous results. Considering conversion and accumulation processes of toxaphene components in the environment, a chlorobornane mixture was prepared yielding a GC-NICI-SIM chromatogram, which resembles very much that of the residues obtained from fish tissues. This mixture can then be used as a representative standard for the exact quantification of toxaphene residues in fish and fish products. (Author's abstract)
W91-04248

COMPARATIVE EVALUATION OF SOXHLET AND SONICATION EXTRACTION IN THE DETERMINATION OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SOIL.
Environmental Monitoring Systems Lab., Las Vegas, NV. Methods Development Branch.
G. M. Brilis, and P. J. Marsden.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 91-98, 1990. 8 fig, 3 tab, 3 ref.

Descriptors: *Analytical methods, *Analytical techniques, *Pollutant identification, *Polycyclic aromatic hydrocarbons, *Sample preparation, *Soil analysis, Experimental data, Experimental design, Sonication extraction, Soxhlet extraction.

The recovery of polynuclear aromatic hydrocarbons (PNAs) from soil is influenced by a number of phenomena: the partition coefficient between the solvent and the sample matrix; the contact between the solvent and the soil particles; and the method of extraction. Accordingly, a study was made to compare the efficiency of the Soxhlet and sonication extraction methods, using different solvent systems, for the analysis of polynuclear aromatic hydrocarbons in soil. Soxhlet extraction using acetone/hexane gave somewhat higher recoveries than sonication with acetone/methylene chloride for most of the creosote contaminated soils. However, sonication may be more effective for free-flowing soil samples that contain low levels (less than 1-2 mg/g total PNAs). There is insufficient data to state that one extraction procedure is consistently best. Because these differences are generally small (approximately 12%), the use of alternate extraction procedures must be considered when analyzing complex samples. The study suggests that analysts need flexibility to use alternative sample preparation procedures when characterizing complex environmental/waste samples. (Korn-PTT)
W91-04251

ORGANIC HALOGEN GROUP PARAMETERS IN GROUND WATER INVESTIGATION, PART III.
Technical Univ. of Denmark, Lyngby. Inst. for Applied Geology.
C. Gron.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 135-152, 1990. 1 fig, 9 tab, 68 ref.

Descriptors: *Analytical methods, *Chlorinated hydrocarbons, *Groundwater pollution, *Halogenated compounds, *Pesticides, *Pollutant identification, *Polychlorinated biphenyls, Absorbable organic halogens, Extractable organic halogens, Humic substances, Iodine, Organic pesticides, Organic solvents, Polarity, Volatile organic compounds, Volatile organic halogens, Volatility.

The majority of the organic contaminants that frequently occur in ground water belong to the group of halogenated organics. A set of analytical methods for the determination of the organic halogen group parameters adsorbable organic halogen (AOX), extractable organic halogens (EOX) and volatile organic halogens (VOX) has been developed and tested for applicability in groundwater studies. Whereas the AOX method covers most organic halogen compounds of common occurrence as groundwater pollutants, the EOX results express the contents of nonpolar compounds such as several chlorinated pesticides and polychlorinated biphenyls (PCBs), and the VOX method includes volatile haloorganics such as frequently used chlorinated solvents. The methods can be applied in the range 0.5-100 micrograms Cl/L with a relative standard deviation of 5-10%. Each method suffers from drawbacks. The recoveries of volatile organic compounds by AOX are slightly low, and the susceptibility to bias by iodide and iodate urges for caution in interpreting elevated AOX values. The EOX method is sensitive to cooccurrence of humic organic matter, which causes reduced recoveries of apolar haloorganics. The recoveries of volatile haloorganics by the VOX method are slightly decreased, if non-halogenated volatile organics such as 1,2-dimethylbenzene are present at the 10 mg/L level. Used in combination, the three organic halogen group parameters constitute a useful and cost effective tool for the evaluation of groundwater pollution with halogenated organics. (Korn-PTT)
W91-04252

LONG-TERM TRENDS OF DDT AND PCB CONCENTRATIONS IN MUSSELS (MYTILUS GALLOPROVINCIALIS).
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
For primary bibliographic entry see Field 5B.
W91-04253

BASELINE ASSESSMENT OF PCDDS/PCDFS IN THE VICINITY OF THE ELK RIVER, MINNESOTA GENERATING STATION.
ENSR, Fort Collins, CO.
For primary bibliographic entry see Field 5B.
W91-04254

DETERMINATION OF MONO- AND NON-ORTHO COPLANAR PCBS IN FISH.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
C. S. Hong, and B. Bush.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 173-181, 1990. 5 fig, 3 tab, 21 ref. NOAA Office of Sea Grant, U. S. Department of Commerce Grant NA90AA-D-SG078.

Descriptors: *Activated carbon, *Analytical techniques, *Aroclors, *Fish, *Gas chromatography, *Path of pollutants, *Pollutant identification, *Polychlorinated biphenyls, *Sample preparation, *Striped bass, Biological samples, Carbon chromatography, High resolution gas chromatography, Hudson River, New York Bight.

An analytical method has been developed for the determination of four non-ortho and eight mono-ortho coplanar PCBs. The need for a simple analytical method for the isolation of mono-and non-ortho coplanar PCBs in environmental samples stems from evidence that a large part of Aroclor liver enzyme induction activity is correlated with the small amounts of those mono-ortho and non-ortho coplanar PCBs present in the Aroclor mixtures. The analytical method fully exploits the potential of activated carbon as an absorbent for the isolation of these PCBs and permits the determination of these PCB residues in fish samples at parts-per-trillion levels. The method combines a simple sulfuric acid cleanup method coupled with carbon chromatography and high-resolution gas chromatography. The analytical technique permits rapid separation and identification of individual PCB congeners. Residues of thes PCB congeners were detected in Hudson River striped bass at 1.7 ppt; residues from fish from other sampling sites in the New York Bight were below the ppt level. The method is also simple, rapid, sensitive and specific for routine analysis for these non-ortho and mono-ortho coplanar PCBs in the environmental samples. (Korn-PTT)
W91-04255

FORMS OF METALS IN A SEDIMENT CORE OF A SEVERELY ACIDIFIED NORTHERN BLACK FOREST LAKE.
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
C. E. W. Steinberg, and H. Hogel.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 201-213, 1990. 12 fig, 2 tab, 28 ref. Umweltbundesamt Berlin, FRG under UFO-Plan Nr. Wasser 10204333.

Descriptors: *Acid lakes, *Acid rain effects, *Heavy metals, *Lakes, *Paleolimnology, *Path of pollutants, *Water pollution sources, Aluminum, Black Forest, Bonding, Bonding strength, Cadmium, Calcium, Chemical speciation, Chromium, Copper, Germany, Iron, Lead, Magnesium, Manganese, Metals, Pollutant identification, Sediment analysis, Sediment chemistry, Sequential chemical extraction, Toxicity, Zinc.

Sequential chemical extraction indicates roughly two major periods of metal enrichments: (1) near and below the 15 cm deep layer, the metal concentrations and speciations seem to be influenced by increased eroding material after a heavy forest fire in 1800, which was indicated by the presence of charcoal in the sediment layers concerned, and emissions of local glass processing industries in historical times. This seems to apply for Cu, Cr, Cd, and Pb. However, there are only slight correlations between these metals; and (2) above 12 cm depth. With Fe, Zn, Cd, Pb, Mg and Ca, this enrichment period exhibits two maxima (around 10-11 cm and above 6-7 cm). Above a depth of 15 cm all metals reflect the most recent history of deposition of so-called air borne pollutants, which is directly or indirectly connected with the acidification of the northern Black Forest. Zn and Cd found in elevated concentrations in fossil fuels, such as coal, show distinct maxima around the 10 cm deep layers. Consequently, the main source of pollutants and acidity in Huzenbachersee is atmospheric deposition, originating from emissions of the adjacent industrial region. In the uppermost sediment layers the bonding strength of several metals showed a decreasing tendency while there was an increasing tendency for exchangeable and easily reducible fractions. As a result, secondary contamination of the water column can occur through sediment release especially with Zn and Cd. (Korn-PTT)
W91-04257

POLYCHLORINATED DIBENZOFURANS IN THE EDIBLE PORTION OF SELECTED FISH.
Food and Drug Administration, Washington, DC. Contaminants Chemistry Div.
For primary bibliographic entry see Field 5B.
W91-04258

ANALYSIS OF ATMOSPHERIC PRECIPITATION BY REVERSED-PHASE ION-PAIR CHROMATOGRAPHY.
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
Q. Xianren, and W. Baeyens.
Journal of Chromatography JOCRAM, Vol. 514, No. 2, p 362-370, August 29, 1990. 5 fig, 4 tab, 14 ref.

Descriptors: *Acid rain, *Aerosols, *Analytical methods, *Chemistry of precipitation, *High performance liquid chromatography, *Precipitation scavenging, *Sulfates, *Water analysis, Anions, Atmospheric chemistry, Atmospheric water, Bromides, Chlorides, Detection limits, Ion exchange chromatography, Nitrates, Nitrites, Reverse-phase ion-pair chromatography, Separation techniques.

In recent years much effort has been applied to the use of high-performance liquid chromatography (HPLC) for the separation and determination of inorganic anions. In the current investigation, a reversed-phase Partisil 10 ODS-3 column was evaluated for the rapid determination of several anions (chloride, nitrite, bromide, nitrate, and sulfate) in environmental samples. It was found that a combination of 8 mM tetrabutylammonium iodide (TBAI) and 1 mM potassium hydrogenphthalate (KHP) at pH 6 was a very suitable eluent for the separation of those anions with this column. The method was applied to rainwater and aerosol samples and the results were compared with those obtained with a PRP-X100 (Hamilton) ion-exchange column. The reproducibility of triplicate measurements ranged between 0.5 and 0.9 % for Cl(-), NO2(-), Br(-), NO3(-), and SO4(2-). The detection limit was 0.1-0.2 ppm with a 100 microliter injection sample volume. An investigation of the reproducibility also revealed that the anion concentrations in rain decrease in a hyperbolic way with the amount of precipitation. The hyperbolic relationship reflects the fact that in the last stages (sequences) of the rainwater samples, the anion concentration tends to a constant value which corresponds to the initial or cloud vapor concentration. This concentration is a measure of the background concentration of the dissolved anions in raindrops. Also, in the initial stages (sequences) of the rainwater samples, the anion concentration is much higher owing to an additional amount of salts which will be incorporated and solubilized in the raindrops during their fall. This additional amount is thus a measure of the scavenging efficiency of anions from aerosols by the raindrops. (Korn-PTT)
W91-04265

CAPILLARY ZONE ELECTROPHORETIC SEPARATION OF CHLOROPHENOLS IN INDUSTRIAL WASTE WATER WITH ON-COLUMN ELECTROCHEMICAL DETECTION.
Anamed Instruments Ltd., Bombay (India). Applictions and Methods Development Lab.
C. D. Gaitonde, and P. V. Pathak.
Journal of Chromatography JOCRAM, Vol. 514, No. 2, p 389-393, August 29, 1990. 4 fig, 1 tab, 26 ref.

Descriptors: *Analytical methods, *Electrophoresis, *Phenols, *Separation techniques, *Wastewater analysis, *Water analysis, Capillary zone electrophoresis, Chlorinated aromatic compounds, Detection limits, Industrial wastewater, Pollutant identification, Wastewater.

Phenolic compounds, in particular chlorinated phenols as pollutants in drinking water, cause concern because of their high toxicity and wide distribution. The release of these chlorophenols through waste water has led to the need for methods for monitoring these compounds in industrial effluents and natural waters. A study was undertaken to investigate the suitability of capillary zone electrophoresis (CZE) for the separation of chlorinated phenols in industrial waste waters. A fused-silica capillary was employed with an applied potential of 20 kV. Attempts were made to optimize the separation conditions by using different capillary lengths of 400, 500, 600, 650, 800, and 1000 mm. Detection was performed with an on-column electrochemical detector using an oxidation potential of (+) 1.4 V and modified with carbon fibres. It is believed that the use of an on-line electrochemical detector provides excellent sensitivity and selectivity without derivatization or tedious extraction of the sample. The results of the experiments indicate that, as the length of the capillary increases beyond 650 mm, the theoretical plate number increases, thereby prolonging the separation of 2-chlorophenol from other components and causing peak broadening. Important contributors to the peak broadening effect were found to be longitudinal diffusion resulting in a flat flow profile and interactions between capillary walls and analytes. Detection levels in the picomole range were achieved with separation efficiencies of the order of 320,000 theoretical plates. (Korn-PTT)
W91-04266

GAS CHROMATOGRAPHIC AND MASS SPECTROMETRIC DETERMINATION OF NITROAROMATICS IN WATER.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
J. Feltes, K. Levsen, D. Volmer, and M. Spiekermann.
Journal of Chromatography JOCRAM, Vol. 518, No. 1, p 21-40, September 28, 1990. 6 fig, 9 tab, 28 ref.

Descriptors: *Analytical methods, *Aromatic compounds, *Electron capture gas chromatography, *Gas chromatography, *Mass spectrometry, *Nitrogen compounds, *Pollutant identification, *Water analysis, Instrumentation, Nitroaromatic compounds, Water quality data.

The determination of a large number of nitro compounds with a variety of functional groups was investigated using gas chromatography with both an electron capture detector (ECD) and chemiluminescence detector (TEA). In addition, the use of gas chromatography/mass spectrometry (GC/MS) with either electron impact (EI), positive-ion chemical ionization (PICI) or negative-ion chemical ionization (NICI) detection was also studied. Nitroaromatic compounds can be extracted from aqueous samples with high recoveries by liquid-liquid extraction with dichloromethane or by adsorption on Amberlite resins, while lower and strongly varying recoveries are found if solid-phase extraction with phenyl-, octadecyl-, or cyano-bonded phases is employed. As a result of their high electron affinities, nitroaromatic compounds can be determined with high sensitivity by GC using ECD. If, however, highly polluted surface water is to be investigated, ECD is not sufficiently selective for an unambiguous compound assignment. In contrast, TEA is much more selective for nitro compounds, allowing a reliable peak assignment if reference compounds are available. The major disadvantage of the TEA detector is its lower sensitivity (compared with the ECD), which precludes the analysis of weakly polluted water. Definite compound assignment can be achieved with GC-MS, where NICI is more sensitive and selective than EI, but gives fewer structure-specific fragments. (Korn-PTT)
W91-04267

SIMULTANEOUS DETERMINATION OF TRACE CONCENTRATIONS OF BENOMYL, CARBENDAZIM (MBC) AND NINE OTHER PESTICIDES IN WATER USING AN AUTOMATED ON-LINE PRE-CONCENTRATION HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC METHOD.
Brock Univ., St. Catharines (Ontario). Dept. of Chemistry.
C. H. Marvin, I. D. Brindle, R. P. Singh, C. D. Hall, and M. Chiba.
Journal of Chromatography JOCRAM, Vol. 518, No. 1, p 242-249, September 28, 1990. 3 fig, 1 tab, 13 ref.

Descriptors: *Analytical methods, *Carbamate pesticides, *Fungicides, *High performance liquid chromatography, *Pesticides, *Pollutant identification, Agricultural runoff, Aminocarb, Barban, Benomyl, Butylate, Captan, Carbaryl, Carbendazim, Carbofuran, Chemical analysis, Chloropropham, Detection limits, Propham, Propoxur, Water analysis, Water quality data.

The analysis of benomyl residues in water is made difficult by the varying instability of the compound in different organic solvents and its low solubility in water. Benomyl also decomposes in water, but at a rate slower than that in organic solvent. High-performance liquid chromatography (HPLC) the usual method for the analysis of benomyl in aqueous media, employs the determination of the degradation product methyl 2-benzimidazolecarbamate (carbendazim or MBC) after quantitative conversion of the benomyl parent compound. The study investigates the use of an HPLC method for the simultaneous determination of benomyl and MBC in aqueous samples at the ppb level. Benomyl is determined as the intact parent compound and any MBC in the sample can be determined exclusively as the natural degradation product. The method incorporates the use of an automated on-line preconcentration column in conjunction with HPLC and ultraviolet (UV) detection. On-line pre-concentration (or trace enrichment) offers the possibility of isolating intact analytes directly from an aqueous sample matrix by retaining them on a solid sorbent contained in a short pre-column. A subsequent valve switching allows the mobile phase to flush analytes from the pre-column to the HPLC analytical column without further sample manipulation. A series tests were conducted to evaluate this analytical method. It was determined that unidirectional elution from a C18 pre-column onto a C18 analytical column was the best combination of experimental conditions. (Korn-PTT)
W91-04268

IMMOBILIZED PLANT THYLAKOID MEMBRANES AS A BIOSENSOR FOR HERBICIDES.
Quebec Univ., Trois-Rivieres. Centre de Recherche en Photobiophysique.
M. Purcell, R. Carpentier, D. Belanger, and G. Fortier.
Biotechnology Techniques BTECE6, Vol. 4, No. 5, p 363-368, September/October 1990. 3 fig, 1 tab, 11 ref.

Descriptors: *Analytical techniques, *Atrazine, *Bioassay, *Diuron, *Electrochemistry, *Herbicides, *Plant tissues, *Pollutant identification, *Toxicity, Biosensors, Biotechnology, Detection limits, Inhibition, Monitoring, Photosynthesis, Spinach, Thylakoid membranes, Water quality.

The monitoring of water toxicity is of great importance since pollution from industrial and agricultural sources has become widespread. Thylakoid membranes isolated from spinach leaves were used as the biological sensing material to elaborate a biosensor for the detection of small amounts of the herbicides atrazine and diuron. Free and immobilized thylakoid membranes were compared for their responses to inhibition by herbicides by following the variation of the photocurrent. The results of the study revealed that the immobilization of thylakoid membranes increased the detection limit for diuron and atrazine. The maximum concentrations of diuron and atrazine that can be retrieved in water are 180 and 330 micromole, respectively, based on their maximal solubility. The limit of detection for both herbicides by the immobilized thylakoid membrane was found to be 1 micromole for atrazine and 0.07 micromole for diuron. (Korn-PTT)
W91-04275

QUALITY ASSURANCE IN ANALYSIS OF ENVIRONMENTAL MATRICES FOR PCDDS AND PCDFS.
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
D. B. Sergeant.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1263-1268, 1990. 9 ref.

Descriptors: *Data quality control, *Dioxins, *Furans, *Halogenated compounds, *Pollutant identification, *Quality control, Analytical techniques, Detection limits, Handbooks, Laboratory methods, Precision, Protocols.

Quality assurance (QA) is an essential part of all analytical programs. It is even more critical when the analyses are performed at the parts-per-trillion or ultra-trace level, which is the case for chlorinated dioxins and dibenzofurans. A comprehensive dioxin/furan QA protocol was developed by the Dioxin Quality Assurance Committee (DQAC) and applied to two different analysis programs. Despite initial program startup problems the document served its purpose well. Initial problems disappeared after 2-3 data sets had been analyzed and reviewed. Intensive communication at the early stages of such contracts would probably eliminate most of these problems. Data was assessed against the QA criteria and either accepted or referred back to the laboratory for resolution of the errors or re-analysis of the sample if the problem indicat-

ed a low surrogate recovery or a severe cleanup problem that could not be removed by performing additional cleanups on the existing sample extract. Use of common standard solutions not only reduces analytical variations between laboratories but also ensures that there were no dilution errors or changes to concentrations due to evaporation over the course of such programs. Revision of the document reflecting some of the recent changes would further improve its effectiveness. (Korn-PTT)
W91-04276

QUALITY ASSURANCE/QUALITY CONTROL ASSESSMENT FOR A COLLABORATIVE STUDY OF 2,3,7,8-TCDD BIOACCUMULATION IN LAKE ONTARIO.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5B.
W91-04277

ASSESSMENT OF REFERENCE MATERIALS FOR APPLICATION TO PCDD/PCDF ANALYSIS.
Zenon Environmental, Inc., Burlington (Ontario).
M. G. Foster, H. Huneault, O. Cosby, R. E. Clement, and C. Tashiro.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1285-1290, 1990. 4 tab, 4 ref.

Descriptors: *Dioxins, *Fly ash, *Furans, *Halogenated compounds, *Laboratory methods, *Plant tissues, *Pollutant identification, *Quality control, *Sediment analysis, *Standard reference materials, *Standards, Analytical techniques, Citrus leaf, Comparison studies, Data analysis, Data quality control, Detection limits, Marine sediments, Precision, River sediments.

The analysis of polychlorinated dibenzo(p)dioxins (PCDD) and dibenzofurans (PCDF) in environmental samples involves many complex steps prior to results generation. In order to assess the applicability of currently available Standard Reference Materials (SRM) to the analysis of PCDDs and PCDFs, a variety of materials representing typical environmental samples were screened for the presence of significant levels of PCDD and PCDF. The screening results identified several new candidates for use as laboratory reference materials for PCDD and PCDF analysis. These included matrices which contained only limited PCDD and PCDF contamination of the higher congener groups. They included municipal fly ash, marine sediment, river sediment, and citrus leaf. Several reference materials, which contained no detectable concentrations of PCDD/PCDF, were found and could be useful adjuncts to a laboratory's quality assurance (QA) program in their application as known blank sample matrices which can be used as method blanks or as blank matrices for spiking studies. An attempt was also made to establish within-lab and between-lab precision between the two laboratories participating in the study based on a more detailed analysis of the selected environmental samples. Intercomparison studies revealed that within-lab precision was similar in both labs. However, significant differences in quantification were observed in the fly ash samples, likely due to methodology variations. Additional methodology studies are required in order to investigate the effect of the variations used, in particular the application of acid digestion to the analysis of fly ash samples. (Korn-PTT)
W91-04278

VALIDATION STUDIES OF AN AUTOMATED PRECONCENTRATION WATER SAMPLER (APS) FOR CHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Ontario Ministry of the Environment, Rexdale.
For primary bibliographic entry see Field 7B.
W91-04280

SUPERCRITICAL FLUID EXTRACTION FOR THE DETERMINATION OF PCDDS AND PCDFS IN SOIL.
Twin City Testing Corp., St. Paul, MN.
F. L. DeRoos, and M. K. L. Bicking.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1355-1361, 1990. 3 tab, 3 ref.

Descriptors: *Analytical methods, *Dioxins, *Furans, *Halogenated compounds, *Pollutant identification, *Separation techniques, *Soil analysis, *Supercritical fluid extraction, Chemical analysis, Data acquisition, Gas chromatography, Mass spectrometry, Soil contamination, Solvents.

Supercritical fluid extraction (SFE) is an extraction procedure which uses a fluid that is in the supercritical state (i.e., above its critical temperature and pressure) as the extraction medium, rather than the typical liquid solvents used for Soxhlet extraction. SFE was evaluated as an alternative procedure to conventional solvent extraction for the determination of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) from three soil samples. Samples were extracted using supercritical carbon dioxide. The sample extracts were then quantified using gas chromatography/mass spectrometry (GC/MS). High recoveries were obtained for all spiked compounds, representing levels of chlorination from tetrachloro-congeners through octochloro-congeners. A comparison of SFE with conventional solvent extraction using a soil known to contain dioxins indicated that the levels obtained by SFE were approximately 30-50% of the levels observed using Soxhlet techniques. However, the potential savings in time and sample preparation costs are so great that additional optimization is warranted. Although additional optimization is necessary, the preliminary data indicate that SFE could be a viable alternative to solvent extraction. (Author's abstract)
W91-04281

DEVELOPMENT OF GC CAPILLARY COLUMN FOR ISOMER-SPECIFIC SEPARATION OF TOXIC ISOMER OF PCDDS AND PCDFS IN ENVIRONMENTAL SAMPLES.
Waterloo Univ. (Ontario). Dept. of Chemistry.
K. P. Naikwadi, and F. W. Karasek.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1379-1384, 1990. 2 fig, 8 ref.

Descriptors: *Analytical methods, *Dioxins, *Furans, *Gas chromatography, *Halogenated compounds, *Hazardous materials, *Instrumentation, *Pollutant identification, *Separation techniques, *Water analysis, Capillary columns, Chemical analysis, Data acquisition, Isomer-specific selectivity, Liquid crystal polysiloxane, Mass spectrometry, Measuring instruments, Selectivity.

The analysis of environmental samples for PCDD and PCDF requires rigorous methodology for positive identification and quantitation. Extreme care is required in sample preparation and measurement procedures in order to eliminate the possibility of false positive or false negative results due to interferences. However, the analytical methodology can be simplified if a special isomer-specific capillary column for gas chromatography (GC) can separate the interfering compounds as well as the isomers in all congener groups of dioxins and dibenzofurans. A new stationary phase for the GC capillary column has been developed. Fused silica capillary tubing was coated by the newly developed liquid crystalline polysiloxane stationary phase. In order to determine the selectivity of this new column, a mixture of PCDD/PCDF and standards of 2,3,7,8-substituted PCDD/PCDF isomers were synthesized. Analysis of PCDD and PCDF were then performed using gas chromatography/mass spectrometry (GC/MS). Results of the investigation revealed that the new column could be used for the analyses of total PCDD/PCDF in all kinds of environmental samples. The most toxic isomer was eluted as the last isomer in all 22 tetra isomers using the new column with GC/MS. In addition, more than a one minute retention time difference was noted between closely eluting isomers. This guarantees no overlap even in the case of column deterioration or very high concentrations of PCDD/PCDF isomers. (Korn-PTT)
W91-04282

APPLICATION OF TANDEM QUADRUPOLE MASS SPECTROMETRY FOR THE ULTRA-TRACE DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
E. J. Reiner, D. H. Schellenberg, V. Y. Taguchi, R. S. Mercer, and J. A. Townsend.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1385-1392, 1990. 4 fig, 1 tab, 18 ref.

Descriptors: *Analytical methods, *Dioxins, *Furans, *Halogenated compounds, *Instrumentation, *Mass spectrometry, *Pollutant identification, *Trace levels, *Water analysis, Chemical analysis, Data acquisition, Detection limits, Gas chromatography, High resolution gas chromatography, High resolution mass spectrometry, Measuring instruments, Milk, Sediment analysis, Selectivity, Separation techniques, Tandem quadrupole mass spectrometry, Wastewater analysis.

The trend in the analysis of chlorinated dibenzo-p-dioxins (CDDs) and dibenzofurans (CDFs) in recent years has been towards searching for much lower levels in more complex matrices. The many interfering compounds and ultra-trace levels of CDD and CDF in matrices such as pulp and paper, sediments, milk, etc., make selectivity a consideration that is as important as sensitivity. Recently, capillary column high resolution gas chromatography/tandem mass spectrometry (HRGC/MS/MS) has shown itself to be an analytical method capable of meeting the requirements of selectivity and sensitivity in CDD and CDF measurements. By using a direct insertion probe containing approximately 1-3 micrograms of CDD and CDF, a triple quadrupole mass spectrometry can be optimized and limits of detection (200 to 600 fg) that begin to approach those obtained by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). A series of sample extract preparations were quantitized using HRGC/MS/MS and the results compared to results obtained using HRGC/HRMS. Both HRGC/MS/MS and HRGC/HRMS were found to filter out different interferences, but neither technique could remove all interferences. However, both techniques appeared to be complimentary. (Korn-PTT)
W91-04283

APPLICATION OF A TWO-DIMENSIONAL REACTION CHROMATOGRAPHY SYSTEM FOR CONFIRMATORY ANALYSIS OF CHLORDANE CONSTITUENTS IN ENVIRONMENTAL SAMPLES.
Missouri Univ.-Columbia. Environmental Trace Substances Research Center.
D. Duebelbeis, S. Kapila, T. E. Clevenger, and A. F. Yanders.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1401-1408, 1990. 9 fig, 11 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Chlordane, *Chromatography, *Gas chromatography, *Halogenated compounds, *Pollutant identification, *Separation techniques, Agricultural runoff, Dual column reaction chromatographic sys, Fish, Instrumentation, Measuring instruments, Pesticides, Polychlorinated dicyclopentadienes, Sediments, Water pollution sources.

A persistent class of toxic chlorinated organics are the polychlorinated dicyclopentadienes. These compounds have been used as pesticides under the trade name of Chlordane for the past forty years and are present in various phases of the environment. A chromatographic method was evaluated for use in determining the level of chlordane in several fish and sediment samples taken from the Meramec river (a tributary of the Missouri river). The analytical method involved the use of a dual column reaction gas chromatographic system. The system can be used in the dual column mode or in the dual column reaction mode. The dual column reaction mode was selected for analysis of the environmental samples. In this mode, the analytes of interest are transferred after separation in the first column. The analyte is then subjected to an in-line reaction in a nickel tube, and the products and

residual analyte are then separated by the second column. The reaction found to be the most amenable for the present system was hydrodehalogenation. By subjecting the analytes to an in-line reaction, a greater degree of certainty was achieved in the sample analyses. The results of the tests revealed the presence of chlorinated dicyclopentadienes in a sediment sample. This was believed to indicate that the chlordane contamination in the Meramec river came from a relatively recent source. In general, the overall results of the investigation demonstrated the applicability of the dual column reaction system for confirmatory analysis of polychlorinated compounds in environmental samples. (Korn-PTT)
W91-04284

USE OF DIMETHYL SULFOXIDE AS SOLUBILIZATION AGENT IN THE DETECTION OF 2,3,7,8-TCDD BY RADIOIMMUNOASSAY.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
J. P. Sherry, J. W. ApSimon, T. L. Collier, and P. W. Albro.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1409-1416, 1990. 4 fig, 3 tab, 13 ref.

Descriptors: *Analytical methods, *Dimethyl sulfoxide, *Dioxins, *Halogenated compounds, *Immunoassay, *Immunochemistry, *Pollutant identification, *Radioactivity techniques, *Separation techniques, *Solubility, *Solvents, Horse serum, Radioimmunoassay, Solubilization.

Immunoassays (IAs) are potentially valuable tools for use in screening environmental samples for a broad range of contaminants, such as polychlorinated dibenzo-p-dioxins (PCDDs). IAs are sensitive and selective tests that are increasingly being used to cost effectively detect environmental contaminants. The quantification steps most commonly used in IAs measure either radioactivity (radioimmunoassay (RIA)) or enzyme activity (enzyme immunoassay (EIA)). In a typical RIA procedure, the analyte competes for antibody binding sites with radio-labelled analyte. The quantity of analyte in a sample is inversely proportional to the amount of bound radioactivity. The performance of the RIA for PCDDs was investigated for this study using 4 solubilization systems. These system included Cutscum, Triton, horse serum, and dimethyl sulfoxide (DMSO). The results of the investigation revealed that the DMSO-based assay appeared to be the most sensitive and was more precise than either the detergent-based or serum-based assays. Besides improving assay response, use of DMSO in the RIA eliminated a solvent removal step and simplified the assay calibration curve's preparation. Finally, it was determined that an acceleration of the separation of bound from unbound radioactivity could be achieved without adversely affecting assay performance. (Korn-PTT)
W91-04285

DEVELOPMENT OF A RAPID SCREENING ASSAY FOR PCDDS AND PCDFS.
Guelph Univ. (Ontario). Dept. of Chemistry and Biochemistry.
N. J. Bunce, R. Logan, and U. A. Schneider.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1417-1422, 1990. 1 fig, 2 tab, 9 ref.

Descriptors: *Analytical methods, *Bioassay, *Dioxins, *Furans, *Halogenated compounds, *Pollutant identification, *Toxicity, Aryl hydrocarbon receptor, Calibration curves, Detection limits, Radioactive tracers, Radioactivity techniques, Structure-activity relationships, Tetrachlorodibenzo-p-dioxins, Toxic equivalency factors, Tritium.

One approach to estimating the toxicity of an environmental sample would be to use some kind of in vitro bioassay, so that an appropriate measure of toxicity of the complete sample could be obtained directly. Many of the toxic responses of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in mammals are mediated through their interaction with an intracellular protein known either as the aryl hydrocarbon (Ah) receptor. This protein binds tetrachlorodibenzo-p-dioxins (TCDD) and stereochemically related compounds with high affinity and specificity. Structure-activity relationships have shown that TCDD binds most strongly to the Ah receptor. Consequently, an assay based upon the strength of binding of the toxicants in an environmental sample to a fixed amount of Ah receptor could form the basis of an assay for PCDDs, PCDFs, and other similar compounds. Such an assay would utilize the Ah receptor as a biochemical reagent, and would be rapid and inexpensive. A total of eleven mixtures were analyzed using this in vitro bioassay. Radiolabelled (tritium) compounds were used to follow the course of the reaction. The experiments were performed as a competition, in which the environmental sample competed with a fixed quantity of radiolabelled PCDD for a fixed quantity of the Ah receptor. The amount of radiolabelled TCDD-Ah receptor complex corresponding to each concentration of unlabelled TCDD was obtained by the use of the hydroxylapatite assay. The preliminary results of the investigation revealed that the mixtures behaved almost additively. The sensitivity and the detection limit of the assay was restricted by the relatively low specific activity of the tritium in the radioactive TCDD. (Korn-PTT)
W91-04286

BROMO- AND BROMOCHLORO-P-DIOXINS AND DIBENZOFURANS IN THE ENVIRONMENT.
Lockheed Engineering and Sciences Co., Inc., Las Vegas, NV.
J. R. Donnelly, A. H. Grange, N. J. Nunn, G. W. Sovocool, and J. J. Breen.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1423-1430, 1990. 1 fig, 1 tab, 19 ref. EPA Contract No. 68-03-3249.

Descriptors: *Analytical methods, *Dioxins, *Furans, *Halogenated compounds, *Instrumentation, *Pollutant identification, *Separation techniques, Automotive fluff waste, Brominated compounds, Detection limits, Extraction techniques, Flame retardants, Fly ash, Gas chromatography, Interference, Mass spectrometry, Monitoring, Polybrominated dibenzofurans, Sample cleanup, Sample preparation, Thermoplastic resins, Water pollution sources.

At least 36 million pounds of brominated flame retardants are used annually in the United Sates. The need for analysis of environmental samples for brominated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and related compounds has recently been recognized. Soxhlet extraction with benzene or toluene was found to be effective for most sample matrices. Extract cleanup was accomplished with EPA-test gravity column technology: multi-phase silica, acidic alumina, and AX-21 carbon on silica. Analysis of the various sample extracts by gas chromatography/mass spectrometry was accomplished with both low resolution and high resolution mass spectrometers. The results of the investigation revealed that the majority of the brominated PCDDs and PCDFs entered the waste stream via thermoplastic resin waste in landfills, municipal incinerator fly ash, and automotive 'fluff' (the ground-up residue from junked cars which remains after the bulk metals have been reclaimed). However, it was determined that the use of high resolution mass spectrometry did not remove analytical interferences in brominated substances. Therefore, emphasis should be placed on the areas of sample preparation and gas chromatographic separation. The use of non-polar gas chromatograph (GC) columns was found to offer two very important advantages: (1) shorter retention times could be achieved with the non-polar columns than with polar GC columns for faster analysis, and (2) PCDD and PCDF retention index models could be applied. However, improvements in GC column phase, film thickness, and bore diameter (to minimize overloading) could also improve the separation of various brominated compounds. (Korn-PTT)
W91-04287

ANALYSIS OF NON-ORTHO POLYCHLORINATED BIPHENYLS AND POLYCHLORINATED NAPHTHALENES IN SWEDISH DIOXIN SURVEY SAMPLES.
National Swedish Environment Protection Board, Solna. Special Analytical Lab.
For primary bibliographic entry see Field 5B.
W91-04290

GC/MS BASED ANALYSES OF INDIVIDUAL ORGANIC CONSTITUENTS OF CHAO PHRAYA RIVER WATER AND ESTIMATED DISCHARGE RATES INTO THE UPPER GULF OF THAILAND.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 5B.
W91-04458

TRACE METAL CONCENTRATIONS IN MANGROVE OYSTER (CRASSOSTREA CORTEZIENSIS) FROM TROPICAL LAGOON ENVIRONMENTS, MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
For primary bibliographic entry see Field 5B.
W91-04525

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: CONCENTRATIONS OF ARSENIC, CADMIUM, COPPER, LEAD, MERCURY, SELENIUM, AND ZINC IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5G.
W91-04578

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: RESIDUES OF ORGANOCHLORINE CHEMICALS IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5G.
W91-04579

SEDIMENT-CONTACT BIOASSAY WITH PHOTOBACTERIUM PHOSPHOREUM.
Redeemer Coll., Ancaster (Ontario).
H. Brouwer, T. Murphy, and L. McArdle.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1353-1358, 1990. 3 fig, 3 tab, 14 ref.

Descriptors: *Bioassay, *Bioindicators, *Bioluminescence, *Microtox assay, *Pollutant identification, *Sediment contamination, Bacteria, Performance evaluation, Polychlorinated biphenyls, Toxicity, Water pollution effects.

The change in the bacterial luminescence when Photobacterium is exposed to toxic chemicals can be used as an indication of organic and metallic toxicity. This study reports a new, rapid test for the toxicity screening of sediments using inhibition of Photobacterium phosphoreum. The bacteria are placed in direct contact with the sediment and the change in luminescence of the Photobacterium is used to determine the toxicity of the sediment relative to a control site. The research site was Hamilton Harbor, a heavily industrialized harbor at the extreme western end of Lake Ontario. Data from the sediment-contact method indicated that the most toxic sites in Hamilton Harbor are found along the southern shore near municipal storm water and industrial discharge pipes. The sediment-contact bioassay appears to be more sensitive to hydrophobic contaminants such as a polychlorinated biphenyl than the standard sediment elutriate test with the Microtox(TM) bioassay. The greatest advantage of the sediment-contact Photobacterium method is that the toxicity of the entire sediment is measured. Most bioassays with whole sediment use Chironomus or Pontoporeia, and are time-consuming and unsuitable for either a screening test or resolution of the spatial variation in toxicity. (Ver-Nooy-PTT)

W91-04626

BIOACCUMULATION BIOASSAY FOR FRESHWATER SEDIMENTS.
Fish and Wildlife Service, Ann Arbor, MI. Great Lakes Fishery Lab.
M. J. Mac, G. E. Noguchi, R. J. Hesselberg, C. C. Edsall, and J. A. Shoesmith.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1405-1414, 1990. 6 tab, 33 ref.

Descriptors: *Bioaccumulation, *Bioassay, *Earthworms, *Lake sediments, *Minnow, *Pollutant identification, *River sediments, *Sediment contamination, *Water pollution effects, Bioavailability, Fathead minnows, Food chains, Heavy metals, Invertebrates, Laboratory methods, Mercury, Mortality, Polychlorinated biphenyls, Toxicity, Zinc.

Sediments pose a particularly difficult resource management problem because of their propensity to act as sources of accumulable contaminants to aquatic organisms and terrestrial biota dependent upon aquatic food chains. A laboratory bioassay is described for determining the bioavailability of contaminants from freshwater sediments. The bioassay consists of 10 day exposures to whole sediments under flow-through conditions. After testing five species, the fathead minnow (Pimephales promelas) and the earthworm (Lumbricus terrestris) were recommended for use in the test. When the availability of polychlorinated biphenyls (PCBs), mercury (Hg) and zinc (Zn) from Great Lakes sediments (Raisin River, Detroit River, and Toledo Harbor) were examined in laboratory exposures, only the PCBs were accumulated. All sediments over 0.1 micrograms/g produced significant bioaccumulation of PCBs in both species. Fathead minnows suffered elevated mortality (27.5% versus 0 to 8.3% in reference sediments) in sediments from the Detroit river site. A field validation study demonstrated that the magnitude of accumulation in laboratory exposures was similar to that in organisms caged in the field. A protocol is recommended for using the test as a standardized bioaccumulation bioassay. (Author's abstract)
W91-04630

BIOTRANSFORMATION ACTIVITIES OF FERAL FISH IN WATERS RECEIVING BLEACHED PULP MILL EFFLUENTS.
Kuopio Univ. (Finland). Dept. of Physiology.
P. Lindstrom-Seppa, and A. Oikari.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1415-1424, 1990. 1 fig, 6 tab, 29 ref.

Descriptors: *Bioindicators, *Biotransformation, *Bleaching wastes, *Bream, *Path of pollutants, *Perch, *Pulp wastes, *Roach, *Water pollution effects, Biochemical tests, Cytochromes, Enzymes, Finland, Lake fisheries, Liver.

Perch (Perca fluviatilis L.), roach (Rutilus rutilus L.) and bream (Abramis brama L.) were collected from an area in the southern part of Lake Saimaa (Finland), which is polluted by effluents from the pulp and paper industry, and compared to fish caught at several upstream locations in the same lake system. Livers were sampled in the field, and polysubstrate monooxygenase (PSMO) activities and other parameters of the microsomal cytochrome P-450 system, as well as conjugation enzymes, were later analyzed in the laboratory. The enzymes assayed included 7-ethoxyresorufin O-deethylase, pentoxyresorufin O-dealkylase, benzo(a)pyrene hydroxylase, UDP-glucuronosyltransferase and glutathione S-transferase. The influence of effluents discharged from the mill, which produces chlorine-beached kraft pulp, was seen in each fish species as elevations of liver PSMO activities. The content of total glutathione was increased in fish collected from the most polluted areas, but the changes in conjugation enzymes were not as clearly related to the pollution gradient. These results were compared to analyses from several control areas located at various distances upstream from the industry investigated. To assess the possible influence of another pulp mill, Baikalsk Cellulose Combine, hepatic PSMO activities of Cottus kessleri and Paracottus kneri, two sculpins endemic to Lake Baikal (USSR), were also measured. No effects were observed. In conclusion, PSMO enzymes analyzed from stationary feral fish can serve as a tool for assessing and monitoring chemical contamination caused by pulp and paper mill effluents. (Author's abstract)
W91-04631

DERIVATION OF A FRESHWATER SILVER CRITERIA FOR THE NEW RIVER, VIRGINIA, USING REPRESENTATIVE SPECIES.
Biological Monitoring, Inc., Blacksburg, VA.
For primary bibliographic entry see Field 5C.
W91-04632

STORAGE TANK MONITORING (EXCLUDES RADIOACTIVE WASTE STORAGE TANKS) (JAN 76--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-866396. Price codes: N01 in paper copy, N01 in microfiche. July 1989. 36p.

Descriptors: *Bibliographies, *Hazardous wastes, *Monitoring, *Storage tanks, *Water pollution sources, *Water quality, Leakage, Path of pollutants, Pesticides, Solvents, Waste disposal.

This bibliography contains citations concerning the monitoring of storage tanks containing toxic and environmentally hazardous materials other than radioactive wastes. Leak testing, leak detecting and leak prediction methods and programs are cited. Major concerns deal with water pollution by substances such as fuels, pesticides, waste soil, and solvents. In addition to leak monitoring, references to inventory and location monitoring are also mentioned. Storage of radioactive wastes is discussed in a separate bibliography. (This new bibliography contains 66 citations fully indexed with a title list). (Author's abstract)
W91-04652

CONTINUOUS AND PASSIVE ENVIRONMENTAL RADON MONITORING: MEASURING METHODS AND HEALTH EFFECTS (JAN 75--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-866719. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 153p.

Descriptors: *Bibliographies, *Data acquisition, *Monitoring, *Path of pollutants, *Radon, Measuring instruments, Public health, Radiation, Spectroscopy.

This bibliography contains citations concerning continuous and passive radon (Rn) and R daughters monitoring, measuring methods, equipment, and health effects from their concentration in air, water, and soils. The design, development, and evaluation of Rn monitoring and detection devices are presented, including alpha spectroscopy and dosimetry, track detecting and scintillation, thermoluminescent, electret, and electrod collection. Sources of Rn concentration levels found in building materials, ventilation systems, soils, and groundwater are considered. Lung cancer associated risks from Rn radiation exposure are examined. Radon monitoring in mining operations is excluded. (This updated bibliography contains 350 citations, 68 of which are new entries to the previous edition.) (Author's abstract)
W91-04654

CORRELATION OF CADMIUM SHELL-WEIGHT INDEX WITH ENVIRONMENTAL STRESS INDICATORS AT THE CELLULAR AND ORGANISMIC LEVELS IN LITTORINA LITTOREA.
Universidad del Pais Vasco, Bilbao (Spain). Zientzi Fakultatea.
I. Marigomez, M. P. Ireland, and E. Angulo.
Marine Ecology Progress Series MESEDT, Vol. 67, No. 2, p 171-176, October 18, 1990. 1 fig, 2 tab, 41 ref. Basque Government Research Project X-86.041 and University of the Basque Country F.P.I. and P. P. Grant, 1988.

Descriptors: *Bioaccumulation, *Bioindicators, *Cadmium, *Mollusks, *Statistical analysis, *Sublethal effects, *Toxicity, *Water pollution effects, Bioavailability, Heavy metals, Regression analysis.

Winkles Littorina littorea were exposed to sublethal concentrations of cadmium (Cd) in the laboratory, and selective parameters indicative of bioavailable contamination and of environmental stress caused by sublethal pollution were calculated. Significant linear correlations were found between the Cd index and the following environmental stress indices: flesh condition index; mean epithelial thickness, mean diverticular radius and mean luminal radius, mean epithelial thickness of the digestive tubules; numerical density and surface density of digestive lysosomes. A significant linear regression was found in all cases, indicating that the changes in all the environmental stress indicators studied may be explained by changes in the organismic Cd index. Such relationships could be applied to field studies in an attempt to estimate the presence of bioavailable contaminants and their effects on living organisms. (Author's abstract)
W91-04719

USE OF ACETYLCHOLINESTERASE ACTIVITY TO DETECT SUBLETHAL TOXICITY IN STREAM INVERTEBRATES EXPOSED TO LOW CONCENTRATIONS OF ORGANOPHOSPHATE INSECTICIDES.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
K. E. Day, and I. M. Scott.
Aquatic Toxicology AQTODG, Vol. 18, No. 2, p 101-114, 1990. 4 fig, 3 tab, 35 ref.

Descriptors: *Acetylcholinesterase, *Bioindicators, *Insecticides, *Invertebrates, *Organophosphorus pesticides, *Sublethal effects, *Toxicity, *Toxicology, Bioassay, Daphnia, Fenitrothion.

Acetylcholinesterase (AChE) activity was measured in selected species of aquatic invertebrates using two methodologies based on the Ellman technique (a modified kit procedure using the spectrophotometer and a microplate assay). Levels of AChE ranged from 12.7 microU/mg protein for Daphnia magna to 96.9 microU/mg protein for Hydropsyche spp. The coefficients of variation (CVs) for the microplate technique were much lower than the CVs for the modified kit procedure (e.g., 6.9 to 25.5% vs. 34.6 to 55.4%) and allowed measurements within single whole organisms or individual head capsules. Exposure of invertebrates to low concentrations of the organophosphate insecticides, azinphosmethyl and fenitrothion, did not result in a significant depression in AChE levels with one exception, i.e. levels of AChE in Hyalella azteca declined to 55.2% of control levels following 24 hr exposure to 2.0 micrograms azinophosmethyl/L. Exposure for longer periods (48 to 96 hr) did not result in reduced levels. Exposure of the stonefly, Claassenia sp., to chlorpyrifos significantly lowered AChE levels by 30.7-45.1% at concentrations approaching lethality (> or = 40 micrograms/L). The results indicate that measurement of the activity of AChE in aquatic invertebrates exposed to field concentrations of organophosphate insecticides may be a useful biochemical technique but only for detecting acute toxicity following exposure in the field. In addition, choice of species may be important in the detection of sublethal effects. (Author's abstract)
W91-04735

PREPARATION OF BENTHIC SUBSTRATES FOR SEDIMENT TOXICITY TESTING.
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
J. K. P. Jones.
Environmental Toxicology and Chemistry

ETOCDK, Vol. 9, No. 12, p 1523-1529, 1990. 1 fig, 2 tab, 17 ref.

Descriptors: *Benthos, *Sample preparation, *Sediments, *Toxicity, Bioassay, Mixing.

A jar-rolling apparatus was constructed to prepare test substrates using sediments spiked with laboratory chemicals, the toxicity of which were assessed with the Rhepoxynius abronius bioassay. Test sediments were mixed by rolling them for several hours in one-gallon glass jars. Mixing was considered adequate based on the analytical results of sediment samples that were collected at locations along the longitudinal axis within each horizontally lying jar immediately after rolling. However, because comparative standards did not exist, definitive conclusions of mixing thoroughness could not be drawn. Coefficients of variation, used to assess mixing within jars, were 11.5% or less (mean 5.1%). Mixing was not significantly different among replicated jars but, in some jars, was significantly different among within-jar sample locations. (Author's abstract)
W91-04748

RELIABILITY OF ANALYSES OF HG, FE, CA, K, P, PH, ALKALINITY, CONDUCTIVITY, HARDNESS AND COLOUR FROM LAKES.
Uppsala Univ. (Sweden). Dept. of Hydrology.
L. Hakanson, H. Borg, and R. Uhrberg.
Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 1, p 79-94, 1990. 8 fig, 8 tab, 19 ref.

Descriptors: *Fish, *Lake sediments, *Mercury, *Metals, *Physicochemical properties, *Pollutant identification, *Quality assurance, *Water analysis, Alkalinity, Calcium, Color, Comparison studies, Conductivity, Data interpretation, Hardness, Hydrogen ion concentration, Iron, Phosphorus, Potassium, Synoptic analysis.

Analytical quality controls of mercury analysis of fish and sediments, and analyses of Fe, Ca, total P, K, pH, alkalinity, conductivity, color and hardness (Ca + Mg) of lake water samples were undertaken by an overall inter-laboratory comparison between the parameters. Results from six laboratories showed that pH gives the lowest (average) relative standard deviation (error) of about 2%. Conductivity gives an error of approximately 5-7%. Alkalinity yields an average error of as much as 13-25%. Color gives a high error of 9-15%. Hardness gives a relative standard deviation of about 6-7%. Of the other parameters (Hg., Fe, Ca, and P), Hg gives the best reliability and Fe and P the lowest. (Author's abstract)
W91-04753

COSTS OF GROUNDWATER CONTAMINATION TO THE SOUTHINGTON WATER WORKS DEPARTMENT.
Southington Water Dept., CT.
G. J. Bligh.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 214-215, September 1990.

Descriptors: *Chlorinated hydrocarbons, *Connecticut, *Estimated costs, *Groundwater pollution, *Volatile organic compounds, Southington, Water resources, Water supply, Wells.

The Southington Water Department in Southington, Connecticut, relied on a groundwater supply of nine wells located throughout the town and a small reservoir system, all of which feed directly into the distribution system. Four of the nine wells have been closed due to contamination by volatile chlorinated hydrocarbon, contaminants. New wellfields have had to be developed, and the estimate to fully develop the new wellfields is between $1.5 million to $2.0 million. Reactivation of the contaminated wells could cost from $2.5 to $4.0 million. It was concluded that the direct costs of additional plant and equipment that were incurred along with the as yet unquantifiable losses of the town's major water resources justifies the funding of a comprehensive aquifer protection program. (White-Reimer-PTT)
W91-04845

5B. Sources Of Pollution

CASE STUDY OF REGIONAL EFFORT: WELLHEAD DELINEATION AS A TOOL FOR FOSTERING REGIONAL COOPERATION.
North Kingstown Dept. of Planning and Development, RI.
M. F. Cohen, and T. Brown.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 37-51. 2 fig, 4 ref.

Descriptors: *Groundwater management, *Groundwater quality, *Regional planning, *Rhode Island, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Aquifer management, Groundwater, Groundwater pollution, Groundwater resources, Legal aspects.

The Hunt Aquifer in Rhode Island has the capacity to deliver eight million gallons of water per day. The waters of the Hunt Aquifer are distributed to a population of over 50,000 people by three different water suppliers. Five public supply wells lie within 1,000 feet of one another. The primary reservoir area is located at the boundary confluence of three municipalities, each with distinct political and land use control. Wellhead delineation has become the vehicle for fostering a regional cooperative effort. The water suppliers have recognized that the results of a wellhead delineation study can be used to (1) determine future acquisitions to protect wellheads; (2) assign locations for monitoring potential contamination sites; and (3) provide information and direction to the three municipalities for land use regulation purposes. Additionally, it was recognized that the proximity of the wells and the likely pumping interaction necessitated a joint effort. To this end the three water suppliers have committed funding available in July, 1989 to contract for consulting services to conduct the wellhead delineation study. Since November 1988, an ad hoc committee composed of representatives of the water suppliers and the municipalities has been meeting to discuss issues related to groundwater protection as well as institutional constraints to regional cooperation. Dissimilar municipal zoning, subdivision, and other regulations are being reviewed. To expand the current information base available for the wellhead study, the water suppliers have authorized a cooperative water quality sampling program for their wells. The municipalities have inventoried land uses with potential for contamination, and respective fire departments have focussed on the well area for MSDS inventorying. Formalization of committee efforts is anticipated. Wellhead delineation became a tool for fostering a regional cooperative effort for protecting the groundwaters of the Hunt Aquifer. (See also W91-03921) (Author's abstract)
W91-03924

MODEL FOR RURAL COMMUNITIES TO ASSESS THREATS TO GROUND WATER QUALITY.
Franklin County Planning Dept., Greenfield, MA.
For primary bibliographic entry see Field 5G.
W91-03925

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
For primary bibliographic entry see Field 5G.
W91-03930

USE OF TIME OF TRAVEL IN ZONE OF CONTRIBUTION DELINEATION AND AQUIFER CONTAMINATION WARNING.
Island Design, New Hartford, CT.
J. C. Hall.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 137-143.

Descriptors: *Computer models, *Groundwater movement, *Model studies, *PLASM model, *Path of pollutants, *Water pollution prevention, *Wellhead protection, Aquifer management, Groundwater, Groundwater management, Groundwater resources.

Determination of the zone of contribution for water supply wells has traditionally depended upon the use of drawdown data under specified conditions. Recent advances in computer modeling make possible the determination of travel time as well as drawdown. Advantages of using travel time rather than drawdown include freedom from the influence of significantly sloping piezometric surfaces, proper accounting for the effects of high permeability strata in the aquifer, proper inclusion of recharge from nearby low-permeability areas, and clear delineation of where monitoring should occur for definite warning times. It is essential that the model used adequately represent, at each node, all of the significant strata and their permeabilities. This in particularly important in glacial sediments. Models are available that are essentially two-dimensional regarding head field output but accept differences in stratigraphy at each node; these are generally preferable to strictly two-dimensional models such as PLASM or three-dimensional models that may require an excessive number of layers. The model should be constructed so that the grid covers the entire watershed of the aquifer, if at all possible. Calibration of models to be used for time of travel outputs must be done with a great deal of care. Permeability should be adjusted for calibration only to the extent that is consistent with the materials and the geologic interpretation of the area. Difficulties in calibration often indicate errors in geologic interpretation, which should be resolved with further field investigation. In general, considerably more input is required to develop a time of travel model than is normally used to develop a simple flow model. (See also W91-03921) (Tappert-PTT)
W91-03931

DEVELOPMENT OF AQUIFER PROTECTION ZONES AND EVALUATION OF CONTAMINATION POTENTIAL IN TOWN OF CHELMSFORD MUNICIPAL WELLS.
Wehran Engineering Corp., Methuen, MA.
For primary bibliographic entry see Field 5G.
W91-03933

DETERMINING THE DEVELOPMENT POTENTIAL WITHIN WELLHEAD PROTECTION AREAS AND RESULTING IMPACTS FROM NITROGEN LOADING.
Horsley, Witten and Hegemann, Inc., Cambridge, Ma.
For primary bibliographic entry see Field 5G.
W91-03934

PLANNING TECHNIQUES FOR ESTIMATING GROUNDWATER IMPACTS OF ON-SITE SEPTIC SYSTEMS.
Camp, Dresser and McKee, Inc., Boston, MA.
E. Beardsley, and C. Lurie.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 237-254. 3 fig, 2 tab, 11 ref.

Descriptors: *Groundwater pollution, *Model studies, *Nitrates, *Nitrogen, *Planning, *Septic tanks, *Water pollution control, *Water pollution sources, Groundwater, Wastewater.

Septic systems rely on several processes for purification of wastewater and pose a potential risk of contamination to groundwater, particularly in

areas with highly permeable soils, high groundwater, or bedrock fractures. Cumulative effects of septic systems make pollution from septic systems a serious hazard to groundwater. There are two distinct approaches to planning and management of individual septic systems; maintenance and rehabilitation of existing systems, and proper siting of future systems. Maintenance, upgrade, and/or rehabilitation of existing systems is critical to prevent pollution of groundwater and is a method for managing existing situations. Planning for the adequate siting of systems can prevent future contamination problems. Two analytical planning techniques can be used to assess the impact of individual septic systems from residential development on groundwater quality: residential build-out analysis and nutrient loading models. Build-out analysis is best used as a rule of thumb analysis to give an idea of order of magnitude of a situation, and to identify geographical areas of concern. Nutrient loading calculations are performed to estimate the nutrient contribution from septic systems to groundwater. Nitrate loading is an important technique because it is the most readily available method for quantifying the cumulative effects of septic systems on groundwater. However, application of this technique should be undertaken with a thorough understanding of its inherent assumptions. Existing septic system regulations of most New England states are limited in that they do not contain an upper limit on permeability, but adopt a site by site rather than cumulative approach to management of septic system siting. (See also W91-03921) (Author's abstract)
W91-03937

PRIVATE WELL PROTECTION IN SAND AND GRAVEL AQUIFERS.
K-V Associates, Inc., Falmouth, MA.
For primary bibliographic entry see Field 5G.
W91-03943

ASSESSMENT OF METAL CONTAMINATION OF SEDIMENTS IN THE HUMBER ESTUARY, U.K.
Hull Univ. (England). Dept. of Applied Biology.
A. Grant, and R. Middleton.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 1, p 71-85, July 1990. 4 fig, 6 tab, 46 ref.

Descriptors: *Estuaries, *Heavy metals, *Humber Estuary, *Path of pollutants, *Sediment chemistry, *Trace metals, Arsenic, Chromium, Copper, Estuarine sediments, Grain size, Iron, Lead, Manganese, Marine sediments, Nickel, Niobium, Normalization, Phosphorus, Titanium, Variability, Yttrium, Zinc.

Overall assessments of the degree of metal contamination in estuarine and marine sediments are difficult because of the variations in analytical procedures between studies and the presence of an unknown natural background in the sediment. Measurement of total (rather than extractable) metal and normalization of concentrations as ratios to an element associated with clays provides a solution to the analytical variations. Expressing these values as enrichment factors relative to pre-industrial sediments from the same environment solves the problem of background knowledge. Levels of anthropogenic enrichment of intertidal sediments in the Humber Estuary have been assessed relative to a baseline provided by sediments deposited in the Humber approximately 5000 years B.P. A sample of consolidated Holocene mud estimated to be at least 100 years old confirmed the appropriateness of this baseline. Normalization relative to Rb, which is not anthropogenically enriched, was the most suitable way to adjust for grain size. Levels of Ti, Fe, P, V, Cr, Mn, Ni, Cu, Zn, As, Y, Nb, and Pb are elevated above this baseline. The most marked enrichments (between 3.5-fold and 6-fold) are of P, As, Pb, Cu, and Zn. Normalized concentrations were spatially rather uniform with two exceptions. A single sample from the north bank showed elevated levels of Pb, Cu, Zn, and Cr. An area receiving effluents from an industrialized zone on the south bank, including two titanium dioxide processing factories, showed high levels of a number of elements, particularly Nb. Nb may be a valuable tracer for effluents from the sulfate process of titanium dioxide extraction. (Author's abstract)
W91-03979

PATHWAYS OF SILVER UPTAKE AND ACCUMULATION BY THE AMERICAN OYSTER (CRASSOSTREA VIRGINICA) IN THE CHESAPEAKE BAY.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
G. R. Abbe, and J. G. Sanders.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 31, No. 2, p 113-123, August 1990. 4 fig, 1 tab, 36 ref.

Descriptors: *Animal metabolism, *Animal physiology, *Bioaccumulation, *Chesapeake Bay, *Mollusks, *Oysters, *Path of pollutants, *Silver, Aquatic animals, Phytoplankton, Sediment chemistry.

The ability of aquatic animals to accumulate and concentrate metals to many times environmental concentrations is found in both plants and animals. Metabolic pathways of silver (Ag) accumulation were examined by exposing hatchery-reared oysters to Ag in a variety of forms including dissolved in water, associated with phytoplankton, and sorbed to sediments. Silver dissolved in water (2 and 5 microg/L) was rapidly accumulated, with oysters reaching soft tissue concentrations of 4 to 6 microg/g (several times that of controls) in 3 to 4 weeks. Uptake was negligible from suspended sediments as oysters rejected the particles as pseudofeces. Uptake of Ag associated with algal cells was negligible also: virtually all of this Ag passed through the oysters and was eliminated in the feces. Thus, the major pathway of accumulation in these studies was from dissolved silver. (Author's abstract)
W91-03980

HEAVY METALS IN THE ANTARCTIC SCALLOP ADAMUSSIUM COLBECKI.
Modena Univ. (Italy). Dipt. di Biologia Animale.
M. Mauri, E. Orlando, M. Nigro, and F. Regoli.
Marine Ecology Progress Series MESEDT, Vol. 67, No. 1, p 27-33, September 20, 1990. 5 fig, 4 tab, 25 ref.

Descriptors: *Antarctica, *Baseline studies, *Bioaccumulation, *Ecosystems, *Heavy metals, *Mollusks, *Scallops, Animal metabolism, Animal physiology, Cadmium, Chromium, Copper, Iron, Manganese, Path of pollutants, Trace metals, Zinc.

Collecting new environmental data will serve as a baseline for evaluating future environmental impact of pollutants in the Antarctic. Copper, iron, chromium, cadmium, manganese, and zinc concentrations were determined in different organs of the Antarctic scallop Adamussium colbecki (Smith) and compared with those found in Pecten jacobeus L., a scallop of temperate waters, and with literature values for other Pectinidae. The digestive gland of A. colbecki was the target organ for copper, iron, chromium, and cadmium, whereas manganese and zinc were found mainly in the kidney. Cadmium concentration in the digestive gland of A. colbecki was higher that in the same organ of P. jacobeus, indicating a marked ability of the Antarctic scallop to concentrate this metal. However, in A. colbecki renal concentrations of both manganese and zinc were considerably lower than those measured in P. jacobeus and other Pectinidae, and may be related to the scarcity of concretions observed in the kidney. (Author's abstract)
W91-04002

CONTINUING IMPORTANCE OF NITRATE CONTAMINATION OF GROUNDWATER AND WELLS IN RURAL AREAS.
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
C. J. Johnson, and B. C. Kross.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 449-456, 1990. 41 ref.

Descriptors: *Drinking water, *Groundwater pollution, *Minnesota, *Nitrates, *Path of pollutants, *Rural areas, *South Dakota, *Water pollution effects, *Wells, Agricultural runoff, Contamination, Epidemiology, Fertilizers, Groundwater, Human population, Livestock, Methemoglobinemia, Mortality, Water quality standards, Well water.

The contamination of groundwater and rural drinking water supplies by nitrates from livestock and human excrement, other organic waste, or chemical fertilizers is a potential hazard throughout the world. Infant illness and death from nitrate-induced methemoglobinemia is probably often misdiagnosed, perhaps as sudden infant death syndrome, and certainly contributes to the national infant death rate statistics. A 1950 report listed 144 cases of infant methemoglobinemia with 14 deaths in one 30-month period in Minnesota. Infant deaths resulting from misdiagnosis of this preventable, treatable intoxication were still occurring as recently as 1986 in South Dakota. In this state, about 39% of dug or bored wells were unsafe due to high nitrate content, compared with 22% of drilled wells and 16% of driven wells. Properly constructed wells more than 30 m deep are more likely to be safe. Groundwater concentrations of nitrate may be unsafe for consumption, and standards are needed to regulate such contamination. Such standards could serve as guidelines and could be enforceable in the case of water systems dependent on wells. (Author's abstract)
W91-04003

NITRATE-N IN THE SOIL PROFILE AND TILE DRAINAGE WATER AS INFLUENCED BY TILLAGE.
Minnesota Univ.-Waseca. Southern Experiment Station.
G. W. Randall.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 457-460, 1990. 3 tab.

Descriptors: *Agricultural practices, *Drainage water, *Nitrates, *Nitrogen, *Nonpoint pollution sources, *Runoff, *Soil chemistry, *Tile drainage, *Tillage, *Water pollution sources, Accumulation, Infiltration, Leaching, Percolation, Precipitation, Rainfall, Soil types.

Conservation tillage systems facilitate the infiltration of greater amounts of precipitation into the soil profile by reducing surface runoff. Higher infiltration and percolation rates are often linked to potentially higher leaching losses of agricultural chemicals. Soil samples were taken in 1 ft increments to a depth of 5 ft to ascertain the accumulation and distribution of nitrate-nitrogen in the soil profile as influenced by tillage. Two long-term tillage studies on fine-textured, clay loam soils were sampled in July and November 1977 following two years of limited rainfall. Nitrate-N accumulation in the 0 to 3 foot profile in late July was reduced by 75% (no tillage) to 38% (chisel plow) compared with the conventional moldboard tillage system in this 8-year-old study. Accumulation in the 0 to 5 foot profile after harvest was 751, 546, 345, and 198 lb nitrate-n/acre for the moldboard plow, chisel-plow, disk-tillage, and no-tillage systems, respectively. Another 3-year study showed accumulations of 625, 619, 468, and 391 lbs nitrate-N/acre after harvest with the moldboard plow, ridge-plant, chisel-plow, and no-tillage systems, respectively. These results indicate that tillage can have substantial effects on the accumulation of nitrate in soils and that additional research is needed to determine the mechanism responsible for these differences. (Author's abstract)
W91-04004

PESTICIDE LOSS TO THE ATMOSPHERE.
Department of Agriculture, Beltsville, MD.
J. R. Plimmer.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 461-466, 1990. 8 ref.

Descriptors: *Air pollution, *Air pollution sources, *Atmospheric chemistry, *Path of pollutants, *Pesticide kinetics, *Pesticides, Air pollution ef-

fects, Groundwater, Particulate matter, Population exposure, Rainfall, Runoff, Volatile organic compounds, Wind erosion.

Pesticides may be transformed by chemical and biological processes or transported from the site of application by several processes including runoff, movement through the soil to ground water, volatilization, transport on soil particles, and wind erosion. Contamination of water by pesticide residues is a matter of concern as is contamination of the earth's atmosphere. The form in which a pesticide enters the air and the dimensions of pesticide-containing particulate matter affect movement and deposition. Local transport over distances of several miles may be responsible for adverse effects on nontarget species. Effects of long-range transport are more difficult to assess, but pesticides increase the burden of organic chemicals in the atmosphere. Field measurements of pesticide volatilization and deposition of residues in rainfall, particulate matter, fog, etc. provide information on the relative importance of these processes. Adequate information concerning chemical reactions of pesticides in air is lacking. Potential losses of pesticide residues to the air should be taken into account in selecting pesticide formulations and application methods, to minimize low-level human and environmental exposure. (Author's abstract)
W91-04005

AGRICULTURAL CHEMICAL MANAGEMENT PRACTICES TO REDUCE LOSSES DUE TO DRAINAGE.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-04006

PERSISTENT POLLUTANTS IN FISH-EATING SEA BIRDS--BIOACCUMULATION, METABOLISM, AND EFFECTS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
C. H. Walker.
Aquatic Toxicology AQTODG, Vol. 17, No. 4, p 293-324, October 1990. 1 fig, 6 tab, 68 ref.

Descriptors: *Bioaccumulation, *Literature review, *Marine pollution, *Metabolism, *Path of pollutants, *Pesticides, *Water birds, *Water pollution effects, DDE, DDT, Dieldrin, Ecosystems, Food chains, Polychlorinated biphenyls, Predation, Toxicity, Trophic level.

Predators tend to be vulnerable to the effects of persistent pollutants. Some very persistent compounds undergo bioaccumulation, as they move up through the trophic levels of ecosystems, with the consequence that predators are exposed to particularly high levels of them. The uptake and bioaccumulation of persistent organic pollutants by fish-eating sea birds is important for two reasons: the possible harmful effects of these pollutants on sea bird populations; and the use of data obtained with sea birds to indicate the pollution of marine ecosystems. Data on persistent residues is primarily for DDE, dieldrin, and PCB congeners, because of the extensive monitoring of these compounds. These compounds are ubiquitous in marine food chains, and the highest concentrations are usually found in sea birds and other terminal predators. The extent to which compounds bioaccumulate with movement through the food chain depends not only upon the metabolic capacity of the different species of seabirds, but also on the ease with which the compounds can be metabolized. PCBs with chlorinated m and p positions will tend to accumulate; others with unsubstituted adjacent m and p positions will tend to be metabolized out. Additive effects such as synergism and potentiation may cause differential toxicity. Fish-eating seabirds can be used to monitor persistent residues in marine ecosystems. The sampling of eggs provides a useful means of systematically monitoring levels in sea bird populations, and has been widely employed. In the future, greater use may be made of the measurement of characteristic biochemical responses to pollutants. (Brunone-PTT)
W91-04011

TRANSBOUNDARY METAL POLLUTION OF THE COLUMBIA RIVER (FRANKLIN D. ROOSEVELT LAKE).
Washington State Dept. of Ecology, Olympia.
A. Johnson, D. Norton, B. Yake, and S. Twiss.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 703-710, November 1990. 1 fig, 3 tab, 15 ref.

Descriptors: *Columbia River, *Heavy metals, *Industrial wastes, *International waters, *Path of pollutants, *Reservoirs, Arsenic, Cadmium, Copper, Lead, Mercury, Sediment analysis, Zinc.

Franklin D. Roosevelt Lake in northeast Washington State is the Columbia River reservoir formed by Grand Coulee Dam. The Washington Department of Ecology has received sporadic water quality alerts from the Geological Survey warning that cadmium and mercury concentrations in the upper reaches of the lake exceeded Environmental Protection Agency water quality criteria. Sediment samples were collected with a 0.1 sq. m. stainless steel van Veen grab along a longitudinal transect from the Canadian border to Grand Coulee Dam and at the mouths of the Colville, Kettle, Spokane, and Sanpoil Rivers, the lake's major tributaries. Samples were analyzed for zinc, copper, lead, arsenic, cadmium, mercury, grain size, and total organic carbon. Strong longitudinal gradients in metals concentrations were evident. Sandy material collected in the upper lake contained the highest concentrations of zinc, copper, and arsenic. Maximum concentrations occurred at the border and decreased rapidly downstream to Kettle Falls, below which they remained relatively constant. Contrasting gradients were observed for cadmium and mercury which increased with relative distance downstream of the border and reached maximum levels in the finer sediments below Kettle Falls. The highest concentrations of lead occurred in the middle reaches of the lake; but the overall range in concentrations was not large. The high metals concentrations in Lake Roosevelt sediments are thought to be primarily due to discharges from the Cominco Limited lead-zinc smelter and refinery, approximately 10 miles above the international border. The steep gradients in Zn, Cu, and As concentrations in upper Lake Roosevelt are probably due to slag which is discharged from Cominco in the form of a coarse-grained sand. The elevated zinc and cadmium concentrations observed in sediments of the Spokane River arm probably reflect mining and related activities along the Coeur d'Alene River in Northern Idaho which resulted in contamination of the Spokane River. (Brunone-PTT)
W91-04016

TISSUE DISTRIBUTION OF MERCURY AND SELENIUM IN MINNOWS, PHOXINUS PHOXINUS.
Southeast Asian Fisheries Development Center, Binangonan (Philippines). Binangonan Freshwater Station.
M. L. A. Cuvin-Aralar, and R. W. Furness.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 775-782, November 1990. 2 fig, 2 tab, 15 ref.

Descriptors: *Bioaccumulation, *Fish physiology, *Mercury, *Minnow, *Path of pollutants, *Selenium, Gut, Histology, Kidneys, Liver, Selenium radioisotopes, Water pollution effects.

The effect of selenium on the distribution pattern of mercury in Phoxinus phoxinus was investigated, as well as the effect of mercury on the tissue distribution of selenium. For the study of tissue distribution of mercury, groups of 14 fish were placed in tanks containing either 0.1 microg/L mercury or 0.1 microg/L selenium. The water was changed each day to maintain mercury and selenium levels. For the study on tissue distribution of selenium, fish were placed in beakers containing either 10 microCi selenium-75 or both 0.1 microg/L mercury and 10 micro Ci selenium-75. Kidneys showed the highest concentration of mercury (1.032 microg/g) and the gonads contained the lowest mercury concentrations. In fish exposed to both mercury and selenium, the kidney also showed the highest mercury content, and the visceral remains, muscle, and gonads had the lowest mercury levels. T-tests showed no significant differences between the two treatments. Results also showed that, with the exception of the kidney, mercury levels in other tissues were generally higher in selenium treated groups, suggesting diversion of mercury to other tissues. The gut and liver had highest concentrations of radioactive selenium, and the muscle tissue had the lowest concentration. Selenium appears to accumulate specifically in the gut and liver, unlike mercury which accumulates in the kidney. (Brunone-PTT)
W91-04025

LEVELS OF POLYCHLORINATED BIPHENYLS, ORGANOCHLORINE PESTICIDES, MERCURY, CADMIUM, COPPER, SELENIUM, ARSENIC, AND ZINC IN THE HARBOUR SEAL, PHOCA VITULINA, IN NORWEGIAN WATERS.
Norges Veterinaerhoegskole, Oslo. Inst. for Farmakologi og Toksikologi.
J. U. Skaare, N. H. Markussen, G. Norheim, S. Haugen, and G. Holt.
Environmental Pollution ENPOEK, Vol. 66, No. 4, p 309-324, 1990. 2 fig, 4 tab, 44 ref.

Descriptors: *Bioaccumulation, *Chlorinated hydrocarbon insecticides, *Heavy metals, *Marine pollution, *Norway, *Path of pollutants, *Pesticides, *Polychlorinated biphenyls, *Seals, Arsenic, Benzene hexachloride, Blubber, Cadmium, Chlordane, Copper, DDT, Liver, Mercury, Selenium, Tissue analysis, Zinc.

Levels of the chlorinated hydrocarbons, polychlorinated biphenyls (PCBs), total DDT, alpha-hexachlorocyclohexane (HCH), beta-HCH, and gamma-HCH, hexachlorobenzene (HCB), and oxychlordane in blubber, and the elements mercury, cadmium, copper, selenium, arsenic, and zinc, in liver, of 82 harbor seals, Phoca vitulina, were determined. The seals were found dead or dying in Norwegian waters during the disease outbreak caused by a morbilli virus in 1988. Of the chlorinated hydrocarbons, the highest concentrations were found of PCBs, which were 2 to 4 times higher than the total DDT concentrations. The PCB and total DDT concentrations ranged from 0.4 to 38 and 0.1 to 8.8 mg/kg, respectively; mercury concentrations ranged from 0.1 to 89 mg/kg. Significantly higher mean levels of PCBs (13 mg/kg) and mercury (16 mg/kg) were found in blubber and liver, respectively, of seals from the southern coast of Norway. The corresponding mean levels in seals from the Oslofjord (8.8 and 4.1 mg/kg) and at the northwestern coast were 5.8 and 7.9 mg/kg, respectively. A significant positive correlation was found between the concentrations of selenium and mercury. When the seals were grouped according to sex and age, females of age-class >1 and pups of both sexes had significantly lower PCB and total DDT levels than males age-class >1. Significantly higher hepatic mercury levels were found in seals age-class >1 as compared to pups. Low levels of the other organochlorines, cadmium, and arsenic, were found. Copper and zinc were considered to be present at normal physiological levels. The organochlorine and heavy metal concentrations gave no support to suggestions that organochlorines and heavy metal pollution may be directly involved in the observed seal deaths. (Author's abstract)
W91-04026

ORGANOCHLORINES IN DIFFERENT FRACTIONS OF SEDIMENTS AND IN DIFFERENT PLANKTONIC COMPARTMENTS OF THE BELGIAN CONTINENTAL SHELF AND THE SCHELDT ESTUARY.
Vrije Univ., Brussels (Belgium). Lab. voor Ecotoxicologie.
K. Delbecke, C. R. Joiris, and M. Bossicart.
Environmental Pollution ENPOEK, Vol. 66, No. 4, p 325-349, 1990. 16 fig, 3 tab, 16 ref.

Descriptors: *Belgium, *Chlorinated hydrocarbons, *Continental shelf, *Estuaries, *Marine sediments, *North Sea, *Path of pollutants, *Plankton, *Scheldt Estuary, *Sediment chemistry, *Toxicology, Adsorption, Distribution patterns, Food

chains, Lipids, Metabolism, Polychlorinated biphenyls, Suspended sediments, Zooplankton.

PCB levels in sediments (bulk and fraction <63 microm), suspended matter and zooplankton from the Belgian continental shelf of the North Sea and the Scheldt estuary were evaluated in relation to their organic carbon content, their lipid content and, for sediments, their particle size distribution. PCB accumulation mechanisms are evaluated, considering the importance of direct contamination (adsorption onto the cell surfaces, absorption through the cell walls and partitioning into the cell lipids) for suspended matter and sediments, and of indirect contamination through the food for zooplankton. Differences in PCB pattern are encountered between the standard mixture, sediments, suspended matter, and zooplankton. PCB residues in the sediments are remobilized after their associated biological matter is mineralized and redistributed in the interstitial water and the water column. Since a certain time is necessary for reaching the sorption/desorption equilibrium between the sediments and the water, local dumping of PCB rich or poor silt can influence the PCB contamination of the sediments in the estuary, but cannot be related to the lipid content of the sediments. A decrease in PCB concentration from the coastal area into the open sea seems to occur in suspended matter and zooplankton. In zooplankton, the PCB levels are higher on a dry weight basis, but lower on a lipid weight basis, than in suspended matter. The absence of a relationship between PCB load and lipid content indicates an indirect contamination through food intake, followed by a dilution of these organochlorines in the autogenically formed, PCB free, zooplankton lipids and a biologically regulated elimination mechanism. (Brunone-PTT)
W91-04027

EXPERIMENTAL STUDY OF NON-UNIFORM FLOW IN GRANULAR POROUS MEDIA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Plant Nutrition.
For primary bibliographic entry see Field 2G.
W91-04029

COLLECTION AND ANALYSIS OF COLLOIDAL PARTICLES TRANSPORTED IN THE MISSISSIPPI RIVER, U.S.A.
Geological Survey, San Diego, CA.
T. F. Rees, and J. F. Ranville.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 241-250, October 1990. 4 fig, 2 tab, 14 ref.

Descriptors: *Colloids, *Mississippi River, *Path of pollutants, *Sediment transport, Illinois River, Missouri River, Particulate matter, Sampling, Suspended sediments, Water analysis.

The U.S. Geological Survey collected, concentrated and characterized colloidal materials from the Mississippi River as part of the Mississippi River Project. Grab samples and discharge-weighted, vertically integrated samples were taken at river mile 179.3 at St. Louis, Missouri. Samples collected on July 22, 1987 illustrate the types of results produced. The St. Louis section is unmixed, and distinct influences from the Illinois, upper Mississippi and Missouri Rivers can be seen from the left bank, mid-channel and right bank, respectively. Total discharge past the St. Louis section on the date sampled was 3900 cu m/sec. Total suspended sediment concentration was 676 mg/L, of which 348 mg/L were colloids < or = 3 microns. Particle size distributions were determined using photon correlation spectroscopy (PCS), photosedimentation analysis (PSA) and scanning electron microscopy (SEM). For PCS, the weight mean was 330 nanometers, polydispersity 0.698, turbidimetric mean 500 nanometers and mass median diameter 277 nanometers. For PSA, the weight mean was 370 nanometers, polydispersity 2.57, turbidometric mean 548 nanometers and mass median diameter 268 nanometers. Except for the polydispersity, both techniques gave very similar results. From the measured distribution, a specific surface area of 10.3 sq m/gm colloid can be calculated. Mineralogy of the Mississippi River colloids at St. Louis were dominated almost entirely by those transported from the Missouri River. Electrophoretic mobilities for colloids collected from the Mississippi River at St. Louis were intermediate between colloids from the Illinois and Missouri Rivers. The presence of organic materials was also indicated by the measured %C for the colloids, which was 5.6% in the Illinois River, 3.3% in the Missouri River and 3.2% in the Mississippi River at St. Louis. Work is under way to elucidate the nature of these coatings. (Geiger-PTT)
W91-04030

COLLOID-RELATED INFILTRATION OF TRACE METALS FROM A RIVER TO SHALLOW GROUNDWATER.
Bern Univ. (Switzerland). Radiochemisches Lab.
U. E. Waber, C. Lienert, and H. R. Von Gunten.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 251-265, October 1990. 3 tab, 25 ref.

Descriptors: *Colloids, *Groundwater pollution, *Path of pollutants, *Surface-groundwater relations, *Trace metals, *Water pollution sources, Aluminum, Aquifers, Cadmium, Copper, Glatt River, Heavy metals, Iron, Manganese, Silicon, Switzerland, Ultrafiltration, Water analysis, Zinc.

The role of colloids for the transport of the trace metals Al, Cd, Cu, Fe, Mn, and Zn was investigated in the River Glatt and in a groundwater infiltration zone near Glattfelden, Switzerland. Ultrafiltration techniques were applied to fractionate colloids in the size range 2-450 nanometers. From the analysis of the above elements, Si and total organic carbon, it was concluded that colloids play a minor role for the transport of trace metals in the river and from the river into the adjacent heterogeneous aquifer. Colloids in the river and in the aquifer show a different element distribution. In general, filtration through 450-nanometers filters is an adequate method for the separation of solids and liquids in natural water systems. The results of the case study may be applied to other shallow heterogeneous aquifers with interstitial porosity. Extended aquifers of this composition are mainly found in Alpine and peri-Alpine locations, but also elsewhere. (Author's abstract)
W91-04031

MODELING OF STRONTIUM SORPTION AND SPECIATION IN A NATURAL SEDIMENT-GROUNDWATER SYSTEM.
Technische Univ. Muenchen, Garching (Germany, F.R.). Lehrstuhl und Inst. fuer Radiochemie.
V. Koss, and J. I. Kim.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 267-280, October 1990. 6 fig, 3 tab, 20 ref. BMFT, Foerderkennzeichen 02 U57 05 2.

Descriptors: *Groundwater pollution, *Model studies, *Path of pollutants, *Sediment transport, *Sorption, *Strontium, Cations, Computer models, Ion exchange, Mathematical models, Radioactive wastes.

The sorption of strontium (Sr) in 21 natural sediment-groundwater systems from Gorleben, Germany was modeled using a simple surface complexation model. An apparent constant of Sr sorption was computed taking into account bulk cation-exchange capacity of the sediment, the analytical composition of groundwater, and experimental sorption data obtained from related systems. The method of determining the prevailing surface complex was described using changing properties of the natural systems. Apparent sorption constants of natural groundwater components, Ca(+2), Mg(+2), K(+), and Na(+), were estimated. Competition from natural groundwater components for sorption were taken into account. Calculations with the geochemical code MINEQL showed groundwater components and SR(2+) to be nearly uncomplexed in groundwaters of sandy systems but considerably complexed in model waters of clayey ones. The main parameters governing Sr(+2) sorption are cation-exchange capacity of the sediment and ionic strength of the groundwater. The apparent formation constants decreased with increasing ionic strength for all supposed surface complexes though an activity coefficient correction is done by MINEQL. The model describes the influence of experimental volume to mass ratio and of Sr(+2) concentration on sorption and allows one to compare the varying sorption data of similar systems. The amount of sorbed Sr(+2) increases with increasing mass to volume ratio, i.e. with increasing sorption site concentration. With increasing concentrations of Sr(+2) the amount of sorbed Sr(+2) increases but the fraction of sorbed Sr(+2) decreases. (Geiger-PTT)
W91-04032

SORPTION OF N-HETEROCYCLIC COMPOUNDS ON REFERENCE AND SUBSURFACE SMECTITE CLAY ISOLATES.
Battelle Pacific Northwest Labs., Richland, WA.
J. M. Zachara, C. C. Ainsworth, and S. C. Smith.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 3, p 281-305, October 1990. 9 fig, 4 tab, 60 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Clays, *Groundwater pollution, *Montmorillonite, *Nitrogen compounds, *Sorption, Adsorption kinetics, Industrial wastes, Ion exchange, Path of pollutants.

The sorption of the nitrogen heterocycle compounds (NHC) pyridine, quinoline and acridine to subsurface materials controls their concentrations in groundwater. The sorption of these compounds was measured from Na and Ca electrolyte solutions on specimen montmorillonite (SWy1) and natural smectite clays isolated from subsurface materials. Sorption was dominated by highly selective exchange for the NHC cation with neutral species sorption noted only at high surface concentrations. The selectivity sequence acridine > quinoline > pyridine was observed on all smectites. Na-saturated SWy1 and natural smectites sorbed NHC compounds comparably. Exchange constants on the Na-smectites were fairly constant with surface coverage and correlated with the octanol-water partition coefficients of the NHC and calculated formal charge on specific atom centers in the molecules. In contrast, the exchange of NHC differed between Ca-saturated SWy1 and natural clays. Ca saturation decreased NHC sorption only on SWy1. Exchange constants for the Ca-smectites varied with surface coverage, and the natural Ca-smectites exhibited higher affinity for NHC than Ca-SWy1. Mineralogic differences between the specimen and natural smectites are believed to effect NHC exchange when the smectite clays are aggregated as quasi-crystals in Ca suspensions. Organic material and Fe-oxides associated with natural smectites had no observable effect on NHC adsorption. (Author's abstract)
W91-04033

CRAYFISH AS A 'BIOLOGICAL INDICATOR' OF AQUATIC CONTAMINATION BY HEAVY METALS.
Laurentian Univ., Sudbury (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5A.
W91-04035

BINDING OF CU(II) TO ALGAE IN A METAL BUFFER.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
H. B. Xue, and L. Sigg.
Water Research WATRAG, Vol. 24, No. 9, p 1129-1136, September 1990. 6 fig, 2 tab, 35 ref.

Descriptors: *Adsorption, *Algae, *Copper, *Metal complexes, *Path of pollutants, Buffering, Fate of pollutants, Heavy metals, Hydrogen ion concentration, Speciation, Toxicity.

The interactions of Cu(II) with algal surfaces and exudates were studied in metal-NTA buffers by a combination of several analytical techniques. Suspensions of living algae in the presence of NTA were titrated at constant pH with Cu(II). The various Cu species were determined as follows: a copper ion selective electrode was used reliably in the pCu range 9-12; differential pulse polarography was used to measure separately Cu(II)-NTA com-

plexes and labile Cu(II) species and to evaluate the complexation of copper by ligands in solution; copper bound to the algal surfaces was extracted by acid treatment and measured by atomic absorption spectrophotometry. Thus, both the binding of Cu to the algal surfaces and to exudates excreted by the algae were determined. The results were interpreted in terms of conditional equilibrium constants valid at a given pH; the conditional constants, both for the binding to the surfaces and with the exudates increase in the pH range 5.0-6.5. Simple equilibrium models using the experimentally determined binding capacities and equilibrium constants were able to simulate the results and to evaluate the speciation of copper. Under the experimental conditions used, the binding of Cu(II) to algal exudates has a more significant effect on copper speciation than the binding to the algal surfaces. These extracellular ligands may play an important role in decreasing the concentration of free copper ion and thus mitigating the potential toxic effects in organisms. (Author's abstract)
W91-04043

DIFFERENT SURFACE GEOLOGY IN DENMARK, THE FAROE ISLANDS AND GREENLAND INFLUENCES THE RADIOLOGICAL CONTAMINATION OF DRINKING WATER.
Risoe National Lab., Roskilde (Denmark). Health Physics Dept.
H. J. M. Hansen, and A. Aarkrog.
Water Research WATRAG, Vol. 24, No. 9, p 1137-1141, September 1990. 3 fig, 3 tab, 10 ref.

Descriptors: *Cesium radioisotopes, *Chernobyl accident, *Denmark, *Drinking water, *Faeroe Islands, *Fallout, *Greenland, *Strontium radioisotopes, *Water pollution sources, Groundwater pollution, Nuclear accidents, Path of pollutants, Population exposure, Streams, Surface water.

The contamination of water resources in Denmark, the Faroe Islands, and Greenland with strontium-90 from nuclear weapons fallout and cesium-137 from the nuclear accident at Chernobyl was compared. Precipitation, groundwater and drinking water samples were collected from various locations throughout the regions and levels of the radioactive isotopes were determined by radioassays. Danish groundwater used as drinking water was nearly totally protected by morainic surface soils from radioactive isotope contamination. Faroese drinking water from streams that run along a peaty soil surface had a 30 times higher contamination level and contributed about 3% to the total contamination of the human diet. The drinking water in Greenland was taken from streams that run along a morainic soil surface. It showed contamination levels that were 100 times higher than in Denmark and contributed about 15% to the total contamination of the human diet during the last 10 years. (Author's abstract)
W91-04044

SPATIAL AND TEMPORAL TRENDS IN ORGANOCHLORINE CONTAMINATION OF DAB (LIMANDA LIMANDA) AND FLOUNDER (PLATICHTHYS FLESUS) IN THE NORTH SEA.
H. Buther.
Archiv fuer Fischereiwissenschaft AVFSAO, Vol. 40, No. 1/2, p 133-152, August 1990. 10 fig, 1 tab, 34 ref.

Descriptors: *Chlorinated hydrocarbons, *Fish, *Marine pollution, *North Sea, *Path of pollutants, Chlorinated aromatic compounds, DDT, Estuaries, Liver, Polychlorinated biphenyls.

Contamination by organochlorine compounds was investigated in flounder (Platichthys flesus) in the German Wadden Sea and its estuaries and in dab (Limanda limanda) in the German Bight and the North Sea. As shown by analyses of their liver fat, the flounders from the Elbe estuary were most highly contaminated with all compounds under investigation, such as pentachlorobenzene (PeCB), hexachlorobenzene (HCB), octachlorostyrene (OCS), the hexachlorocyclohexanes (HCHs), DDT and its metabolites DDE and DDD (DDTs), and the polychlorinated biphenyls (PCBs). Concentrations of PCBs, which is responsible for most of the contamination of fishes with these compounds, were similar in flounders from the estuaries of the Weser and Ems to those in flounders from the Elbe estuary. In the inner German Bight the contamination in dab liver was two to ten times lower than in the fat of flounder liver in the Elbe estuary. In the area of the German Bight a trend of decreasing concentrations towards offshore stations was noted. However, over the whole area of the North Sea this trend was no longer apparent for some compounds, and indeed partly reversed (e.g., for alpha-HCH). In an interregional comparison in May 1988, dabs in the international incineration area for chlorinated wastes in the North Sea were most highly contaminated with HCB and especially OCS. From 1979 until 1988, decreasing organochlorine concentrations were found only for alpha-HCH, DDT, and DDD. The contamination of dabs with PCBs and DDE was highest in May 1988. It is therefore recommended that more easily decomposable and less toxic substitutes for organochlorine compounds be developed. (Author's abstract)
W91-04053

TRANSFORMATION OF CARBON TETRACHLORIDE BY PSEUDOMONAS SP. STRAIN KC UNDER DENITRIFICATION CONDITIONS.
Stanford Univ., CA. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5G.
W91-04060

CHLOROPHENOL DEGRADATION COUPLED TO SULFATE REDUCTION.
New York Univ. Medical Center, NY. Dept. of Microbiology.
M. M. Haggblom, and L. Y. Young.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3255-3260, November 1990. 3 tab, 3 fig, 38 ref. EPA Grant CR-814611 and Public Health Service Grant ESO 4895.

Descriptors: *Biodegradation, *Chlorinated hydrocarbons, *Fate of pollutants, *Phenols, *Sulfates, Biological oxidation, Bioremediation, Degradation, Estuarine sediments, Halogenated hydrocarbons, Molybdate, Sulfur bacteria, Waste treatment, Wastewater treatment.

Chlorinated phenols are common environmental contaminants, often formed as by-products when chlorine is used for bleaching of pulp, and for the disinfection of drinking water and wastewater. Chlorophenol degradation was studied under sulfate-reducing conditions with an estuarine sediment inoculum taken from the East River, New York City. These cultures degraded 0.1 millimoles 2-chlorophenol, 3-chlorophenol, 4-chlorophenol and 2,4-dichlorophenol within 120 to 220 days, but after refeeding with chlorophenols degradation took place in 40 days or less. Further refeeding greatly enhanced the rate of degradation. Sulfate consumption by the cultures corresponded to the stoichiometric values expected for complete oxidation of the chlorophenol to CO2. Formation of sulfide from sulfate was confirmed with a radiotracer technique. No methane was formed, verifying that sulfate reduction was the electron sink. Addition of molybdate, a specific inhibitor of sulfate reduction, inhibited chlorophenol degradation completely. These results indicate that the chlorophenols were mineralized under sulfidogenic conditions and that substrate oxidation was coupled to sulfate reduction. In acclimated cultures the three monochlorophenol isomers and 2,4-dichlorophenol were degraded at rates of 8 to 37 micromoles/L/day. The relative rates of degradation were 4-chlorophenol > 3-chlorophenol > 2-chlorophenol, 2,4-dichlorophenol. Sulfidogenic cultures initiated with biomass from an anaerobic bioreactor used in the treatment of pulp-bleaching effluents dechlorinated 2,4-dichlorophenol to 4-chlorophenol, which persisted, whereas 2,6-dichlorophenol was sequentially dechlorinated first to 2-chlorophenol and then to phenol. (Mertz-PTT)
W91-04061

DISSIMILATORY SELENATE REDUCTION POTENTIALS IN A DIVERSITY OF SEDIMENT TYPES.
Geological Survey, Menlo Park, CA. Water Resources Div.
N. A. Steinberg, and R. S. Oremland.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3550-3557, November 1990. 5 fig, 3 tab, 27 ref.

Descriptors: *Agricultural water, *Anaerobic bacteria, *Biodegradation, *Path of pollutants, *Sediment contamination, *Selenium, Bacteria, Chemical reduction, Fate of pollutants, Hydrogen ion concentration, Nevada, Organic carbon, Salinity.

The presence of toxic selenium oxyanions in agricultural wastewaters which drain from seleniferous soils is wide-spread in the western United States and poses serious environmental problems. Dissimilatory reduction of selenate, primarily to elemental selenium, occurs in anaerobic sediments. Potential rates of bacterial dissimilatory reduction of 75-SeO4(2-) to 75-Se(0) in a diversity of sediment types were measured. Salinities ranged from freshwater (salinity = 1 g/L) to hypersaline (salinity + 320 g/L) and pH values ranged from 7.1 to 9.8. Significant biological selenate reduction occurred in all samples with salinities from 1 to 250 g/L but not in samples with a salinity of 320 g/L. Potential selenate reduction rates ranged from 0.07 to 22 micromoles of SeO4(2-) reduced/L/hour. Activity followed Michaelis-Menten kinetics in relation to SeO4(2-) concentration. There was no linear correlation between potential rates of SeO4(2-) reduction and salinity, pH, concentrations of total Se, porosity, or organic carbon in the sediments. However, potential selenate reduction was correlated with apparent kinetics reflecting enzymatic affinity for selenate and with potential rates of denitrification. NO3(-), NO2(-), MoO4(2-), and WO4(2-) inhibited selenate reduction activity to different extents in sediments from both Hunter Drain and Massie Slough, Nevada. Sulfate partially inhibited activity in sediment from freshwater Massie Slough samples but not from the saline Hunter Drain samples. Dissimilatory selenate reduction in sediments appears widespread in nature. In addition, in situ selenate reduction is a first-order reaction, because the ambient concentrations of selenium oxyanions in the sediments were orders of magnitude less than their kinetic parameter reflecting enzymatic affinity for selenate. (Mertz-PTT)
W91-04066

IDENTIFICATION AND CATABOLIC ACTIVITY OF WELL-DERIVED GASOLINE-DEGRADING BACTERIA FROM A CONTAMINATED AQUIFER.
Orange County Water District, Fountain Valley, CA. Biotechnology Dept.
H. F. Ridgeway, J. Safarik, D. Phipps, P. Carl, and D. Clark.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3565-3575, November 1990. 6 fig, 2 tab, 30 ref. USGS Grant 14-08-0001-G1126.

Descriptors: *Bacteria, *Biodegradation, *Biological treatment, *Fate of pollutants, *Gasoline, *Hydrocarbons, *Water pollution treatment, Aquatic bacteria, Aquifers, Bacterial analysis, Benzenes, Degradation, Groundwater pollution, Microbial degradation, Microorganisms, Organic compounds, Pseudomonas, Toluene, Xylenes.

Many gasoline hydrocarbons can be biodegraded or co-metabolized by native groundwater microflora given appropriate inorganic nutrient supplementation. Approximately 300 gasoline-degrading bacteria were isolated from well water and core material from a shallow coastal aquifer contaminated with unleaded gasoline. The aquifer was underlying the U.S Naval Weapons Station in Seal Beach, California. Identification of 244 isolates revealed four genera: Pseudomonas, Alcaligenes, Nocardia, and Micrococcus, with pseudomonads making up 86.9% of bacteria identified. A total of 297 isolates was sorted into 111 catabolic groups on the basis of aerobic growth responses on 15

gasoline hydrocarbons. Each test hydrocarbon was degraded by at least one isolate. Toluene, p-xylene, ethylbenzene, and 1,2,4-trimethylbenzene were most frequently utilized as growth substrates, whereas cyclic and branched alkanes were least utilized. Most isolates were able to grow on 2 or 3 different hydrocarbons, and nearly 75% utilized toluene as a sole source of carbon and energy. Isolates were remarkably specific for hydrocarbon usage, often catabolizing only one of several closely related compounds. A subset of 220 isolates was sorted into 51 groups by polyacrylamide gel electrophoresis. Pseudomonas aeruginosa was partitioned into 16 protein-banding groups whose catabolic activities were largely restricted to substituted aromatics. Different growth responses on the same hydrocarbon, implying marked strain diversity. The catabolic activities of well-derived, gasoline-degrading bacteria associated with this contaminated aquifer are consonant with in situ adaptation at the site. (Mertz-PTT)
W91-04068

KINETIC MODEL FOR BIOCONCENTRATION OF LIPOPHILIC COMPOUNDS BY OLIGOCHAETES.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
A. J. Gabric, D. W. Connell, and P. R. Bell.
Water Research WATRAG, Vol. 24, No. 10, p 1225-1231, October 1990. 1 tab, 5 fig, 13 ref.

Descriptors: *Bioconcentration, *Biological magnification, *Interstitial water, *Kinetics, *Mathematical models, *Oligochaetes, *Organic compounds, *Path of pollutants, Annelids, Equilibrium, Mathematical studies, Soil water.

Bioconcentration of lipophilic compounds by oligochaete worms was modelled as consecutive partition equilibria--first between sediment and interstitial water, and then between interstitial water and worm. Each interphase process was assumed to proceed according to first order kinetics. The resulting expression for the biotic concentration as a function of time was fitted to experimental data over the range of 3 </= log Kow (octanol to water partition coefficient) </= 6 by varying the kinetic rate constants using a constrained, nonlinear least squares procedure. Relationships between uptake and clearance rate constants and log Kow were in accord with existing theory. The regression equation between the equilibrium bioconcentration factor, (Kb) and Kow also was in general agreement with previous relationships established for other aquatic organisms. For many of the high Kow compounds equilibration times were longer than could be reasonably achieved in laboratory experiments. The methodology presented has an advantage in that it does not require the establishment of equilibrium for the estimation of Kb since the ratio of derived rate constants rather than biotic and water concentrations was used. (Author's abstract)
W91-04076

DISTRIBUTION OF MYCOBACTERIA IN DIFFERENT TYPES OF WATER IN ISRAEL.
Hadassah Medical School, Jerusalem (Israel). Dept. of Environmental Health.
H. Haas, and B. Fattal.
Water Research WATRAG, Vol. 24, No. 10, p 1233-1235, October 1990. 1 fig, 3 tab, 18 ref.

Descriptors: *Distribution patterns, *Israel, *Microbiological studies, *Mycobacterium, *Water pollution sources, Drinking water, Microorganisms, Pathogenic microorganisms, Pollutant identification, Species composition, Wastewater analysis, Water analysis, Water quality, Water sampling.

Infections caused by mycobacteria other than Mycobacterium tuberculosis are increasingly reported. The atypical mycobacteria are environmental microorganisms widely distributed in nature; their main reservoir is water. People susceptible to disease caused by atypical mycobacteria are mostly immunocompromised patients, but severe infections in otherwise healthy people have also been reported. Seventy-five water samples were collected from 26 sampling sites in Israel and examined for the presence of atypical mycobacteria. Different species of mycobacteria which were normally widely distributed in the environment were found in 16 (21%) of the samples with the number of wastewater positives two times higher than that found in the non-wastewater. Seven species of atypical mycobacteria, some of which could be pathogenic to man, were isolated; three were found only in non-wastewater, one in wastewater and the remainder were detected in both. The most common species were Mycobacterium nonchromogenicum, M. gordonae, and M. terrae. (Mertz-PTT)
W91-04077

MODELLING THE CONSUMPTION OF DISSOLVED CONTAMINANTS BY BIOFILM PERIPHYTON IN OPEN-CHANNEL FLOW.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
Y. L. Lau.
Water Research WATRAG, Vol. 24, No. 10, p 1269-1274, October 1990. 4 fig, 13 ref.

Descriptors: *Biofilms, *Fate of pollutants, *Model studies, *Open-channel flow, *Path of pollutants, *Periphyton, *Self-purification, Algae, Bacteria, Chemical wastes, Microorganisms, Streambeds, Water treatment.

Stable surfaces in stream beds are often covered by a layer of slime which is actually an attached film of bacteria, algae and other materials. Microbiological, physical and chemical activity within the biofilm or periphyton can remove the dissolved chemicals from the water above the film and can contribute significantly to the purification process in shallow, flowing streams. An analytical model is developed of the decrease in dissolved contaminant concentration in an open channel flow through the consumption by a bottom biofilm. This idealized model considers the flux of the contaminant by: (1) diffusion through the concentration boundary layer into the biofilm; and (2) diffusion and reaction within the biofilm. Solutions for zero-order kinetics were derived that show that the rate of change of the concentration in the main flow is directly related to the kinetics within the biofilm. It has been shown that the diffusion resistance through the concentration boundary layer just above the biofilm is directly proportional to the thickness of the layer, and that changes in the sublayer thickness can significantly affect the rate of decrease of the substrate concentration in the main flow. (Mertz-PTT)
W91-04082

SHORTCOMINGS OF GRAN TITRATION PROCEDURES FOR DETERMINATION OF ALKALINITY AND WEAK ACIDS IN HUMIC WATER.
National Inst. of Public Health, Oslo (Norway).
For primary bibliographic entry see Field 7B.
W91-04087

USE OF PRACTICAL ASPECTS OF SOIL BEHAVIOUR TO EVALUATE DIFFERENT METHODS TO GENERATE SOIL HYDRAULIC FUNCTIONS.
Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W91-04100

PROCESSES OF WATER MOVEMENT THROUGH A CHALK COOMBE DEPOSIT IN SOUTHEAST ENGLAND.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W91-04104

SOLUTION OF THE TRANSPORT EQUATION BY THE COLLOCATION METHOD IN CONJUNCTION WITH THE ADAPTIVE HERMITE ELEMENT FAMILY.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering.
M. A. Bhuiyan, R. I. Allayla, T. Hussain, A. M. Ishaq, and M. F. N. Mohsen.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2661-2677, November 1990. 14 fig, 8 ref, 2 append.

Descriptors: *Advection, *Dispersion, *Finite element analysis, *Mathematical models, *Model studies, *Path of pollutants, *Plumes, *Solute transport, Data interpretation, Finite element method, Mathematical analysis, Mathematical studies.

The advection-dispersion transport equation behaves as a first-order hyperbolic equation rather than as a second-order parabolic equation due to advection dominance. The solution of the advection-dominated transport equation exhibits behavior whose structure is localized in small subregions of the spatial domain. This requires placing a high-resolution spatial grid in their vicinity. In an attempt to increase the spatial resolution, a family of 16 adaptive Hermite elements was developed. Collocation methodology in conjunction with these adaptive families produced a matrix whose bandwidth was larger than using cubic Hermite elements all over the solution domain. A special technique was devised to condense out this bandwidth prior to the solution of the global system. The numerical solutions were tested against the available one-dimensional and two-dimensional analytical solutions. For the discretization attempted, the code was tested up to a Peclet number of 600 in one dimension and 200 in two dimensions. The analysis demonstrated the feasibility of employing the adaptive Hermitian element family in the solution of the advection-dispersion transport equation in a collocation-finite element approach. The developed code compared well with analytical solutions in both one and two dimensions. The method was shown to be exceedingly accurate for problems involving solutions exhibiting sharp fronts. In one-dimensional analysis, the use of a higher-order element near a steep gradient front demonstrated a more judicious allocation of computational effort than using higher-order elements everywhere. This explained the rapid rate of convergence for adaptive elements. (Mertz-PTT)
W91-04121

EVALUATION OF FIVE SIMULATION MODELS FOR PREDICTING ALDICARB AND BROMIDE BEHAVIOR UNDER FIELD CONDITIONS.
Florida Univ., Gainesville. Dept. of Soil Science.
K. D. Pennel, A. G. Hornsby, R. E. Jessup, and P.S.C. Rao.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2679-2693, November 1990. 11 fig, 7 tab, 30 ref. Florida Department of Environmental Regulation contracts WH-149 and WM-255.

Descriptors: *Aldicarb, *Bromides, *Groundwater pollution, *Model studies, *Path of pollutants, *Simulation analysis, Comparison studies, Computer models, Degradation, Leaching, Pesticides, Solute transport.

Five pesticide simulation models (Chemical Movement in Layered Soils (CLMS), Method of Underground Solute Evaluation (MOUSE), Pesticide Root Zone Model (PRZM), Groundwater Leading Effects of Agriculture Management Systems (GLEAMS), and Leaching Estimation and Chemistry Model-Pesticides (LEACHMP)) were evaluated using data for the transport and transformation of aldicarb and bromide in the unsaturated zone. Although these models have been tested separately, to date no effort has been made to evaluate all of them using a comprehensive data set from a single field study. Model performance was evaluated based on their ability to predict: the depth of solute center of mass, solute dissipation, and solute concentration distributions within the soil profile. GLEAMS and MOUSE models underestimated bromide and alicarb dissipation, while the other models provided satisfactory predictions of both solute center of mass and pesticide degradation. None of the models accurately described measured solute concentration distributions. The selection of either CMLS, LEACHMP, or PRZM models should be based on the availability of input

data, output desired, soil properties, and the pesticide to be simulated. CMLS was easy to use and provided graphs and tabular output. It is recommended as both a management and teaching tool. PLRZM model is recommended as a management model for users who desire concentration distributions but are not interested in the behavior of metabolites, or select pesticides that do not have metabolites of environmental concern. The LEACHMP model was the most complex of the five models and was the most difficult to execute; therefore it is recommended for use by scientists and experienced modelers who desire simulations of all pesticide components. Due to MOUSE model input and output constraints, it is recommended as an educational tool. The GLEAMS model appeared to have limited utility for predicting pesticide fate and transport in the unsaturated zone. (Mertz-PTT)
W91-04122

CELL ANALYTICAL-NUMERICAL METHOD FOR SOLUTION OF THE ADVECTION-DISPERSION EQUATION: TWO-DIMENSIONAL PROBLEMS.
Illinois Univ., Urbana. Dept. of Civil Engineering.
O. A. Elnawawy, A. J. Valocchi, and A. M. Ougouag.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2705-2716, November 1990. 10 fig, 2 tab, 27 ref, 2 append. NSF Grant ECE 84-18644 and USGS Grant 14-08-001-G1299.

Descriptors: *Groundwater movement, *Mathematical studies, *Model studies, *Path of pollutants, *Solute transport, Analytical methods, Data interpretation, Groundwater, Hydraulics, Mathematical equations, Mathematical models.

A new numerical scheme for the efficient solution of groundwater solute transport problems was developed and evaluated, called the cell analytical-numerical (CAN) method. This method is an extension of the so-called nodal methods that have been developed in the nuclear engineering area for solving neutron diffusion problems. The cell analytical-numerical method is based upon decomposition of the solution domain into a number of rectangular cells (volume subdomains); each cell is homogeneous so that a local analytic solution to the solute transport equation can be obtained. A first-order accurate finite difference approximation of the time derivative followed by a transverse averaging procedure is used to transform the governing partial differential equation into a set of coupled one-dimensional ordinary differential equations for the transverse moments of the concentration. The local analytical solution is therefore found in terms of these moments. Solute mass flux continuity across cell surfaces, along with the local analytical solution, is used to construct an algebraic relationship between concentration moment values at adjacent cell surfaces. Assembling all the cells together results in a set of coupled tridiagonal matrix equations, one set for each spatial direction, which can be solved very efficiently. The cell analytical-numerical method is applied to several simple test problems involving uniform flow in homogeneous aquifers. While the method lacks geometrical flexibility, it offers a spatial approximation that is demonstrated to have high accuracy and minimal grid orientation error, even when applied to coarse meshes. (Author's abstract)
W91-04124

COMPARISON OF PHOTON CORRELATION SPECTROSCOPY WITH PHOTOSEDIMENTATION ANALYSIS FOR THE DETERMINATION OF AQUEOUS COLLOID SIZE DISTRIBUTIONS.
Geological Survey, San Diego, CA.
T. F. Rees.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2777-2781, November 1990. 1 fig, 3 tab, 9 ref.

Descriptors: *Colloids, *Data acquisition, *Instrumentation, *Path of pollutants, *Spectroscopy, *Water analysis, Geochemistry, Sediment transport, Sedimentation, Solute transport, Water pollution sources.

Colloidal materials, dispersed phases with dimensions between 0.001 and 1 micrometer, are potential transport media for a variety of contaminants in surface and groundwater. Characterization of these colloids, and identification of the parameters that control their movement, are necessary before transport simulations can be attempted. Two techniques that can be used to determine the particle size distribution of colloidal materials suspended in natural waters are compared. Photon correlation spectroscopy utilizes the Doppler frequency shift of photons scattered off particles undergoing Brownian motion to determine the size of colloids suspended in water. Photosedimentation analysis measures the time-dependent change in optical density of a suspension of colloidal particles undergoing centrifugation. A description of both techniques, important underlying assumptions, and limitations are given. Results for a series of river water samples show that the colloid-size distribution means are statistically identical as determined by both techniques. This is also true of the mass median diameter, even though mass media diameter values determined by photosedimentation analysis are consistently smaller than those determined by particle size spectroscopy. Because of this small negative bias, the skew parameters for the distributions are generally smaller for the particle size spectroscopy-determined distributions than for the photosedimentation analysis-determined distributions. Smaller polydispersity indices for the distributions can also be determined by particle-size spectroscopy. (Author's abstract)
W91-04131

DISSOLUTION OF TRAPPED NONAQUEOUS PHASE LIQUIDS: MASS TRANSFER CHARACTERISTICS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
C. T. Miller, M. M. Poirier-McNeill, and A. S. Mayer.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2783-2796, November 1990. 10 fig, 3 tab, 69 ref.

Descriptors: *Groundwater pollution, *Mass transfer, *Path of pollutants, *Toluene, Flow velocity, Solute transport.

Many groundwater contamination incidents begin with the release of an essentially immiscible fluid into the subsurface environment. Once in the subsurface, an immiscible fluid participates in a complex pattern of transport processes. For immiscible fluids that are commonly found in contaminated groundwater environments the interphase mass transfer between the nonaqueous phase liquid phase and the aqueous phase is an important process. An experimental apparatus and procedure were used to isolate and measure mass transfer between toluene and water in glass bead media systems. The rate of interphase mass transfer was investigated in two-fluid systems as a function of aqueous phase velocity, aqueous and nonaqueous-phase fluid saturations, and porous media characteristics. The rate of interphase mass transfer was found to be directly related to aqueous phase velocity and nonaqueous phase fluid saturation level, but no significant relation to mean particle size was found. Correlation expressions for the rate of interphase mass transfer were developed using relevant dimensionless parameters and were compared to literature values. Equilibrium between the two fluid phases investigated was shown to be achieved rapidly over wide ranges of nonaqueous phase fluid saturations and aqueous phase velocities. The derived correlations provided a means for estimating the appropriateness of the local equilibrium assumption for a nonaqueous phase liquid-aqueous phase couple in multiphase groundwater systems. (Author's abstract)
W91-04132

USE OF NUCLEAR MAGNETIC RESONANCE AS AN EXPERIMENTAL PROBE IN MULTIPHASE SYSTEMS: DETERMINATION OF THE INSTRUMENT WEIGHT FUNCTION FOR MEASUREMENTS OF LIQUID-PHASE VOLUME FRACTIONS.
California Univ., Davis.
For primary bibliographic entry see Field 7B.
W91-04134

DIFFUSION IN THE MATRIX OF GRANITIC ROCK: FIELD TEST IN THE STRIP A MINE.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W91-04137

DEW CHEMISTRY AND ACID DEPOSITION IN GLENDORA, CALIFORNIA, DURING THE 1986 CARBONACEOUS SPECIES METHODS COMPARISON STUDY.
Ford Motor Co., Dearborn, MI. Research Staff.
W. R. Pierson, and W. W. Brachaczek.
Aerosol Science and Technology ASTYDQ, Vol. 12, p 8-27, 1990. 5 tab, 57 ref.

Descriptors: *Acid rain, *Acidic water, *California, *Dew, *Path of pollutants, *Water chemistry, *Water pollution sources, Acidification, Dry deposition, Glendora, Hydrogen ion concentration, Nitric acid, Organic acids, Sulfur, Sulfuric acid.

Dew was collected and analyzed during the Carbonaceous Species Methods Comparison Study in the Los Angeles basin (Glendora, California) in August 1986. Formate, acetate, and other carboxylate anions were consistently observed, with formate generally being the most abundant anion in the dew. These carboxylate anions appear to be attributable to deposition of carboxylic acids from the ambient air. Free acid (H+) was only about one-fifth of the total dew acidity; carboxylic acids could have accounted for half of the remainder. The H+ concentrations were far lower than in dew in the northeast United States (respective pH averages 4.7 and 4.0). Whereas dew in the Northeast was essentially a dilute nitric acid/sulfuric acid mixture, that in Glendora contained substantial amounts of many other inorganic species. S(IV) in the dew in Glendora was stable against oxidation, even by hydrogen peroxide, probably signifying formation of the bisulfite adduct with formaldehyde (considerable amounts of formaldehyde and acetaldehyde were present), in contrast to the S(IV) behavior in dew in the Northeast. The Glendora dew results are consistent with 1985 observations in Claremont, 17 km away. Dew appears to play only a minor role in the acid deposition budget in the Los Angeles basin. Daytime dry deposition of nitric acid (g) (and possibly of carboxylic acids) is far more important. In turn, dry deposition appears to be far more important than rainfall in the acid deposition budget of the Los Angeles basin, which is yet probably far smaller per unit surface area than in parts of the Northeast. (Author's abstract)
W91-04138

PCB MOVEMENT, DECHLORINATION, AND DETOXICATION IN THE ACUSHNET ESTUARY.
General Electric Co., Schenectady, NY. Research and Development Center.
J. F. Brown, and R. E. Wagner.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1215-1233, 1990. 5 fig, 5 tab, 29 ref.

Descriptors: *Biodegradation, *Estuarine sediments, *Fate of pollutants, *Marine sediments, *Path of pollutants, *Polychlorinated biphenyls, *Sediment contamination, Acushnet Estuary, Aroclors, Marine pollution, Massachusetts, New Bedford, Solute transport.

Congener-specific analyses of the polychlorinated biphenyls (PCBs) in Acushnet Estuary (New Bedford, Massachusetts) sediments and waters were undertaken to identify the PCB alteration and transport processes occurring in coastal marine sediments. These analyses indicated that (1) the PCBs deposited at the sediment sites sampled had originally consisted of Aroclors 1242 and 1254, in widely varying proportions; (2) these PCBs had undergone vertical movement within the sediments, rather than remaining stratified, but not

horizontal translocation between sites; (3) they had also undergone extraction into the water, albeit at declining rates, with some consequent changes in composition; but (4) the major compositional change was caused by a previously unreported type of reductive dechlorination process, designated process H. This presumably anaerobic microbial process, subsequently identified at several other locations as well, had selectively removed non-ortho chlorines from most of the higher PCB congeners, especially those associated with acute toxic effects. It appeared to have begun near the upper end of the estuary and not yet reached its lower portions, thus providing a marker for tracing the origins of the PCBs in estuarine water samples. (Author's abstract)
W91-04141

ANAEROBIC MICROBIAL DEGRADATION OF ACRIDINE AND THE APPLICATION OF REMOTE FIBER SPECTROSCOPY TO MONITOR THE TRANSFORMATION PROCESS.
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
J. P. Knezovich, D. J. Bishop, T. J. Kulp, D. Grbic-Galic, and J. Dewitt.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1235-1243, 1990. 5 fig, 1 tab, 28 ref. Dept. of Energy Contract W-7405-Eng-48.

Descriptors: *Anaerobic bacteria, *Analytical methods, *Biodegradation, *Fate of pollutants, *In situ tests, *Laboratory methods, *Organic compounds, Acridine, Anaerobic conditions, Microbial degradation, Oxidation, Polycyclic aromatic hydrocarbons, Remote fiber spectroscopy, Spectroscopy.

Anaerobic microbial transformation of a polynuclear nitrogen heterocycle, acridine, was studied in laboratory microcosms with three different inocula: a stabilized, mixed culture growing on ferulic acid that was originally enriched from anaerobic sewage sludge, and sulfate-reducing and methanogenic aquifer materials from two sites at a groundwater aquifer contaminated by landfill leachate. Acridine degradation was investigated under methanogenic, denitrifying and sulfate-reducing conditions at concentrations of 1 to 6 microg/ml. Substrate degradation was followed using two standard analytical techniques (high performance liquid chromatography and gas chromatography/mass spectrometry (GC/MS)) and a new, in situ remote fiber spectroscopic (RFS) technique. This RFS was used successfully to follow changes in concentration of acridine with time, which indicates that the technique has a significant potential for monitoring the degradation process in environmental media. Acridine was degraded extensively in one to three weeks under each of the conditions studied. A range of heterocyclic, homocyclic aromatic and aliphatic intermediates was identified by GC/MS analyses. On the basis of these compounds, a tentative route of anaerobic acridine transformation is proposed that begins with oxidation and proceeds through the common degradative route for oxidized aromatic compounds. (Author's abstract)
W91-04142

MONITORING LINEAR ALKYL BENZENE SULFONATE IN THE ENVIRONMENT: 1973-1986.
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
R. A. Rapaport, and W. S. Eckhoff.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1245-1257, 1990. 6 fig, 6 tab, 25 ref.

Descriptors: *Biodegradation, *Detergents, *Organic compounds, *Path of pollutants, *Surfactants, *Wastewater treatment, *Water pollution control, *Water quality, Linear alkyl benzene sulfonate, Monitoring, Sludge, Soil amendments, Soil contamination, Wastewater analysis.

Linear alkyl benzene sulfonate (LAS) is the major anionic surfactant used at present in detergent formulations, comprising an estimated 28% of all synthetic surfactants. Results from extensive monitoring from 1973 to 1986 indicate that LAS is extensively removed by sewage treatment with resulting river water concentrations in the low ppb range. Wastewater treatment plant removal efficiencies exceed those for biochemical oxygen demand (BOD); they average 98% for activated sludge, 80% for trickling filters and 27% for primary clarification. Concentrations in influent sewage (mean 3.5 mg/L), effluent sewage (mean 0.06-2.1 mg/L), and in river waters (<0.005-0.3 mg/L) are in agreement with predicted concentrations and measurements by other investigators. Levels of LAS in soil cores analyzed shortly after sludge amendment range from <3 to 47 mg/kg and are consistent with sludge loading rates and biodegradation of LAS from the previous year's sludge application. Removal of LAS occurs by biodegradation in all compartments and sorption/settling from the water column. Longer chain length, more sorptive LAS homologs are relatively enriched in sludge soils and in river sediments; thus the average LAS chain length was found to be higher in those compartments. Results obtained from long-term monitoring support the rapid removal of LAS by biodegradation in the environment. (Author's abstract)
W91-04143

SORPTION OF ORGANIC ACID COMPOUNDS TO SEDIMENTS: INITIAL MODEL DEVELOPMENT.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
C. T. Jafvert.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1259-1268, 1990. 7 fig, 3 tab, 16 ref.

Descriptors: *Adsorption, *Fate of pollutants, *Mathematical models, *Model studies, *Organic acids, *Path of pollutants, *Sediments, Anions, Dissociation constant, Hydrogen ion concentration, Organic compounds, Sediment contamination, Sorption.

The adsorption to sediments and saturated soils of selected organic acid compounds, which significantly affects their movement and persistence in the environment, was examined as a function of compound and sediment properties. Intrinsic compound properties examined included the dissociation constant (pKa) and hydrophobic character. Properties of the sediment examined included ionic strength and composition, organic carbon content and aqueous phase pH. By varying these properties, adsorption of both the neutral and anionic forms of these compounds was shown to occur. Adsorption of the neutral species occurs similarly to that of other hydrophobic compounds that do not contain acidic functional groups. Adsorption of the anionic species to a specific sediment was modeled as a linearly dependent function of pH. Compounds used in the study included 2,4-dinitro-o-cresol (DNOC), 2-(2,4,5-trichlorophenoxy)propanoic acid (silvex), pentachlorophenol (PCP), 4-chloro-a-(4-chlorophenyl)benzeneacetic acid (DDA) and 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB). (Author's abstract)
W91-04144

LIPID-PARTITIONING AND DISPOSITION OF BENZO(A)PYRENE AND HEXACHLOROBIPHENYL IN LAKE MICHIGAN PONTOPOREIA HOYI AND MYSIS RELICTA.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
W. S. Gardner, F. F. Landrum, and J. F. Cavaletto.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1269-1278, 1990. 4 fig, 4 tab, 25 ref.

Descriptors: *Aromatic compounds, *Bioaccumulation, *Biotransformation, *Invertebrates, *Lipids, *Organic compounds, *Path of pollutants, Amphipods, Aquatic animals, Benz(a)pyrene, Crustaceans, Hexachlorobiphenyl, Lake Michigan.

Two Lake Michigan macroinvertebrates, Pontoporeia hoyi and Mysis relicta, exhibited major differences in the disposition of the lipophilic contaminants, (H-3)benzo(a)pyrene (BaP) and (C-14)2,4,5,2',4',5'-hexachlorobiphenyl (HCB). Interactions of these contaminants with major lipid classes (triglycerols and phospholipids) were examined by centrifuging aqueous whole organism homogenates of labeled animals into three discrete layers that were operationally defined as 'buoyant-lipid', 'particle', and 'aqueous' fractions. The buoyant-lipid fraction contained most of the energy storing triacylglycerols, whereas the particle and aqueous fractions contained most of the membrane phospholipids. During 2 to 4 d experiments, unmodified BaP and HCB partitioned among the three fractions in proportion to the distribution of total lipids in both species, but in M. relicta most of the BaP was biotransformed into polar metabolites that were selectively found in the aqueous and particle fractions. Apparently HCB was not substantially biotransformed in either species but took longer (about 2 d) to reach steady state among lipid pools in M. relicta than it did in P. hoyi (<1 d). Although the contaminants did not always completely reach steady state in the organisms with respect to the external environments during these relatively short experiments, they appeared to reach steady state among lipid pools within the organisms. (Author's abstract)
W91-04145

CHLOROACETONES IN PULP MILL CHLORINATION-STAGE EFFLUENTS.
CanSyn Chemical Corp., Toronto (Ontario).
A. B. Mckague, D. Bradley, H. P. Meier, D. Monteith, and J. L. Betts.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1301-1303, 1990. 2 tab, 16 ref.

Descriptors: *Acute toxicity, *Chloroacetones, *Effluents, *Industrial wastes, *Path of pollutants, *Pulp wastes, *Water pollution effects, Canada, Chlorinated hydrocarbons, Chlorination, Fish, Lethal limit, Pulp and paper industry.

Chloroacetones in chlorination-stage effluents from a variety of Canadian pulp and paper mills were analyzed and tested for acute toxicity in juvenile rainbow trout (Salmo gairdneri). Ninety-six hour LC50 values for 1,1,3-trichloroacetone, 1,1,3,3-tetrachloroacetone, pentachloroacetone, and hexachloroacetone for S. gairdneri were 2.3, 11.0, 25.0, and >25 mg/L, respectively. Levels in chlorination-stage effluents from eight pulp mills sampled across Canada were as follows: trichloroacetone, <0.1 to 2.4 mg/L; tetrachloroacetone, 0.4 to 6.9 mg/L; pentachloroacetone, 0.1 to 7.5 mg/L; and hexachloroacetone, <0.1 to 0.6 mg/L. Combined levels of chloroacetones ranged from 0.9 to 17.0 mg/L. The results indicate that combined levels of chloroacetones contribute to the acute toxicity of chlorination-stage effluent to fish. Because the chloroacetones are unstable, they do not pose an environmental threat and have not been identified in final mill effluent. (MacKeen-PTT)
W91-04150

SURFACE-WATER CONTAINMENT ROUTING USING A DIGITAL STREAM INFORMATION SYSTEM.
Geological Survey, Portland, OR.
T. M. Broad.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 203-215, 7 fig, 8 ref.

Descriptors: *Data storage and retrieval, *Databases, *Geographic information systems, *Path of pollutants, *Routing, *Traveltime, *Water resources data, *Water use, *Water use data, Case studies, Flow profiles, Information systems, Oregon, Surface water, Umqua River.

The US Geological Survey (USGS) is proposing to redesign its site specific water use database into a topologic site-specific water use database that depicts water use as an integral part of the hydro-

logic cycle. This new database is to be compatible with the theory of geographic information systems. By placing water use and other hydrologic data into the geographic information system framework, a Stream Information System (SIS) can be developed. A SIS allows a user to combine the spatial and topologic attributes of a basin with stream characteristics, such as discharge, gradient, sinuosity, length, time of travel, and water use to develop models that simulate discharge, time of travel, supply and demand, and solute transport. One application of the SIS is explored for the Umqua River of southwestern Oregon, where most users rely on surface water supplies. These surface water supplies are occasionally contaminated by tractor trailer spills or by overflows of sewage treatment plants. Time-of travel data are integrated into the SIS to predict the time required for a contaminant to travel from the spill site to a downstream user at a known value of discharge. (See also W91-04161) (Author's abstract)
W91-04185

POPULATIONS AFFECTED BY PESTICIDES IN PUBLIC GROUND-WATER SUPPLIES IN IOWA.
Geological Survey, Iowa City, IA. Water Resources Div.
J. N. Thamke, and M. L. Clark.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 381-388, 3 fig, 1 tab, 11 ref.

Descriptors: *Groundwater pollution, *Iowa, *Path of pollutants, *Pesticides, *Public health, *Water quality, *Water use data, Alachlor, Atrazine, Cyanazine, Metolachlor, Metribuzin, Monitoring, Terbufos, Water quality control, Water supply.

During 1987, nearly 200 public supply wells in Iowa were sampled for detectable concentrations of pesticides. It was demonstrated that 50 public supply wells contained detectable concentrations of one or more pesticides. The pesticides, in decreasing frequency of detection were: atrazine, metolaclor, alachlor, cyanazine, metribuzin, and terbufos. During 1987, a total of 25,200 million gallons of water were withdrawn by the 50 public supplies to serve a population of 310,000 which is nearly 11% of the total population in Iowa. Atrazine was detected in 47 public supplies which withdrew 24,600 million gallons of groundwater during 1987 and served a population of 297,000. Twelve public supplies with detectable concentrations of metolachlor in their wells withdrew 11,200 million gallons and served 141,000 people. Alachlor was detected in samples from 9 public supplies which withdrew 430 million gallons of groundwater and served a population of 9,420. The 8 public supplies with detection of cyanazine withdrew nearly 204 million gallons of groundwater and delivered water to 4,980 people. Metribuzin was detected in 8 public supplies which withdrew nearly 281 million gallons of groundwater and served a population of 6,430. Only one public supply had a detectable level of terbufos, and withdrew 0.73 million gallons of groundwater to serve 74 people. (See also W91-04161) (Author's abstract)
W91-04202

CHARACTERISTIC CHLORINATED HYDROCARBON PATTERNS IN THE BLUBBER OF SEALS FROM DIFFERENT MARINE REGIONS.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Lebensmittelchemie.
B. Luckas, W. Vetter, P. Fischer, G. Heidemann, and J. Plotz.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 13-19, 1990. 4 fig, 1 tab, 11 ref.

Descriptors: *Arctic Ocean, *Baltic Sea, *Chlorinated hydrocarbons, *Gas chromatography, *North Atlantic Ocean, *North Sea, *Path of pollutants, *Polychlorinated biphenyls, *Seals, *Spatial distribution, *Weddell Sea, Benzene hexachloride, Blubber, DDT, Hexachlorobenzene, Pollutant identification.

The investigation of occurrence and distribution of chlorinated hydrocarbon compounds, such as hexachlorobenzene (HCB), hexachlorocyclohexane isomers (HCH), p,p'-DDT and its metabolites (p,p'-DDE and p,p'-DDD) and polychlorinated biphenyls (PCB), have shown significant differences between several marine regions. Samples of seal blubber from several marine regions (Arctic, Iceland, North Sea, Baltic, and Antarctica) were analyzed, using a gas chromatograph, for chlorinated hydrocarbon contamination. The blubber was obtained from Common Seals (Phoca vitulina) of the North Sea, the Baltic Sea and the North Atlantic, Ringed Seals (Pusa hispida) caught in the Arctic region, as well as Weddell Seals (Leptonychotes weddellii) of the Weddell Sea. Varying concentrations of organochlorines in the blubber resulted in characteristic contamination patterns. The results of the study showed that remarkably high amounts of HCH and HCB were found in the blubber of animals from the Arctic and Antarctic regions. The DDT contamination increases from the Arctic to southern waters. However, DDT-pertaining residues are found in substantial amount in all regions, even in the Antarctic. PCB content in seals from the northern hemisphere increases even more markedly from the north to the south. In samples from the Antarctic, PCB are also present but do not dominate the chromatograms. Seals from the North Sea and the Baltic display almost equal PCB content in the blubber. The synoptical consideration of selected organochlorine residue concentrations allows an evaluation of both regional loads and global expansion of pollution with chlorinated hydrocarbons. (Korn-PTT)
W91-04247

IMPORTANCE OF SPHEROIDAL CARBONACEOUS PARTICLES (SCPS) FOR THE DISTRIBUTION OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN AN ESTUARINE-LIKE URBAN COASTAL WATER AREA.
Stockholm Univ. (Sweden). Dept. of Zoology.
D. Broman, C. Naf, M. Wik, and I. Renberg.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 69-77, 1990. 3 fig, 3 tab, 13 ref.

Descriptors: *Particulate matter, *Path of pollutants, *Polycyclic aromatic hydrocarbons, Aerosols, Air pollution, Baltic Sea, Carcinogens, Correlation analysis, Data acquisition, Gas chromatography, Mass spectrometry, Settling particulate matter, Suspended particulate matter, Sweden.

Polycyclic aromatic hydrocarbons (PAHs) constitute a large group of toxic compounds which originate from the incomplete combustion of organic material and of which some also have a mutagenic and/or carcinogenic potential. Earlier investigations have shown that PAHs, to a large extent, are associated with the sub-micron fraction of particulate matter of atmospheric aerosols. To investigate the correlation between PAHs and spheroidal carbonaceous particles (SCPs) derived from fossil fuel combustion, analyses were carried out on suspended particulate matter (SUPM) and settling particulate matter (SPM) along the coastal waters of the Baltic Sea near Stockholm. The SUPM was collected with a large volume tangential flow filtration technique and the SPM was collected with sediment traps at different stations at different depths and seasons. A total of 18 PAH samples were analyzed using gas chromatography/mass spectrometry techniques. Of the 18 PAHs analyzed, all except anthracene, 1-, and 3-methylphenanthrene, 2-methylpyrene, and perylene showed significant correlations ($r = 0.81$-0.93) to the SCPs. Because of the gravitational settling capacity of the SCPs, the deposition patterns in the surroundings of a point-source ought to have a more pronounced exponential decline than the submicron particles. The long residence time in the atmosphere for the sub-micron particles probably results in a relatively uniform distribution except for those areas surrounding the source. Because of the porous and hollow composition of the coarse carbonaceous particles analyzed here, the gravitational settling in air is probably slower than could be calculated from the optical diameter (> 0.3 cm/s) and makes the settling area around a point source larger than could be expected. (Korn-PTT)
W91-04249

CHARACTERISTIC CONTAMINATION LEVELS FOR POLYCHLORINATED HYDROCARBONS, DIBENZOFURANS AND DIBENZO-P-DIOXINS IN BREAM (ABRAMIS BRAMA) FROM THE RIVER ELBE.
Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Lebensmittelchemie.
B. Luckas, and M. Oehme.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 79-89, 1990. 3 fig, 2 tab, 25 ref.

Descriptors: *Bioaccumulation, *Bream, *Chlorinated hydrocarbons, *DDD, *DDE, *DDT, *Dioxins, *Fish, *Path of pollutants, *Polychlorinated biphenyls, *Pulp wastes, Benzene hexachloride, Elbe River, Estuaries, Furans, Gas chromatography, Germany, Hexachlorobenzene, Octochlorostyrene, Pesticides, Water pollution sources, Weser River.

A preliminary study of the content of polychlorinated pesticides and aromatics in flounder from the Weser and Elbe estuary in the Federal Republic of Germany showed significant differences in the concentration ratios between the different compounds. Mainly polychlorinated biphenyls (PCB) and very low amounts of hexachlorobenzene (HCB), octachlorostyrene (OCS), hexachlorocyclohexanes (HCH), DDT and DDT-metabolites were found in fish from the Weser. Flounder from the Elbe were heavily contaminated with HCB, OCS, p,p'-DDD and p,p'-DDE in addition to the relatively high levels of PCB. To investigate the origin of these contaminants further, fish from 8 different sites of the river Elbe were collected in the spring of 1986. Polychlorinated pesticides, aromatics, dibenzofurans (PCDF) and dibenzo-p-dioxins (PCDD) were determined in bream from these 8 different locations. All samples taken from the estuary (river km 675) to the border of the German Democratic Republic (river km 492) showed a very similar pattern where HCB and OCS were the dominant compounds. HCB and OCS are mainly formed as undesired byproducts of industrial procedures such as metal processing where chlorine and carbon are present at high temperature or as a result of catalytic reactions. Furthermore, beta-HCH and p,p'-DDD are the most abundant compounds of the HCH and DDT group, respectively, which is different compared to studies of fish from other rivers. Taking the low fat percentage of $<1\%$ (w/w) into account, considerable concentrations of PCDF and PCDD were found in 5 single samples. Two pulp mills were identified as sources. In addition, 2,3,7,8-chlorine-substituted PCDF was found to be the most pronounced isomer in the bream samples. (Korn-PTT)
W91-04250

LONG-TERM TRENDS OF DDT AND PCB CONCENTRATIONS IN MUSSELS (MYTILUS GALLOPROVINCIALIS).
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
N. Picer, and M. Picer.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 153-158, 1990. 3 fig, 1 tab, 10 ref.

Descriptors: *Bioindicators, *Chlorinated hydrocarbons, *DDT, *Mussels, *Mytilus, *PCB, *Path of pollutants, *Pollutant identification, *Water pollution sources, Adriatic Sea, Mediterranean Sea, Mollusks, Regression analysis, Rijeka Bay.

As early as 1973, declining DDT residues in estuarine mollusks in the Mediterranean Sea were noted. Although mussels are a very popular indicator organism for metal and organic pollutants, there is a very limited amount of information available describing the long-term monitoring of DDTs and polychlorinated biphenyls (PCBs) in mussels. Samples of mussel tissue were collected from various places in the Rijeka Bay in the Adriatic Sea. The results of the investigation showed that total DDT and PCB concentrations in mussels from the Rijeka Bay declined from 1974 to 1989. DDT concentrations declined in a manner following first order loss kinetics, confirmed by linear regression

analysis after the logarithmic linearization of the concentration data. The slowing in the decline of PCBs may signify that the decline in the environmental concentrations brought about by existing bans and restrictions on the use of these compounds has been achieved, and a new equilibrium is being approached. In addition, the study indicated that DDT and PCB levels in mussel tissue often differed dramatically in samples collected at the same time from nearby stations. This was believed to be due to the fact that the waters of the first station had been contaminated with waste waters and those of the second station had not. Therefore it is necessary to be very cautious in using mussels as indicator organisms for the estimation of chlorinated hydrocarbon pollution in the larger marine ecosystem. (Korn-PTT)
W91-04253

BASELINE ASSESSMENT OF PCDDS/PCDFS IN THE VICINITY OF THE ELK RIVER, MINNESOTA GENERATING STATION.
ENSR, Fort Collins, CO.
L. W. Reed, G. T. Hunt, B. E. Maisel, M. Hoyt, and D. Keefe.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 159-171, 1990. 3 fig, 4 tab, 16 ref.

Descriptors: *Baseline studies, *Dioxins, *Path of pollutants, *Pollutant identification, *Sediment analysis, *Soil analysis, *Water pollution sources, Agriculture, Elk River, Fish, Furans, Hay, Maize, Minnesota, Seasonal variation.

A study of tetra-, through octa-chlorinated dioxins and furans in multiple media has been performed at a the Elk River Electric Generating Station (ERGS) in Elk River, Minnesota. The investigation assessed background polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF) levels in various media, including air, soil, hay, corn, sediment, and fish. The land use surrounding the facility is dominated by agriculture. The average ambient wintertime PCDDs/PCDFs data for the Cl4 through Cl8 congener class sums showed a profile suggesting combustion source influence, with higher average concentration following increased chlorine substitution. This profile was more pronounced in the summertime samples. Also, average ambient summertime levels of the tetra through octa congener classes were lower than those observed during wintertime. The soils data were high in the octachlorinated isomers, OCDD (340-3300 ppt) and OCDF (nd-269 ppt). The corn and hay measurements are believed to represent deposition on the foliage of dioxin and dibenzofuran-contaminated dust. The hay had measurements for a greater number of isomers than corn. All crop samples had OCDD with corn ranging from 72-168 ppt OCDD and hay ranging from 270-297 ppt OCDD. The aquatic systems were similar to transition areas from rural to urban. The sediment samples had profiles similar to combustion sources. In the fish samples no 2,3,7,8-TCDD was identified. However, one fish had 3.9 ppt total TCDD. All fish samples were found to have 2,3,7,8-TCDF. The Mississippi River samples had more isomers than Lake Orono and for the isomers in common the concentrations were higher in the Mississippi River fish samples. The fish samples had lower concentrations of all isomers than contaminated water bodies such as Lake Erie and Lake Ontario. (Korn-PTT)
W91-04254

DETERMINATION OF MONO- AND NON-ORTHO COPLANAR PCBS IN FISH.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5A.
W91-04255

BEHAVIOR OF DIAZINON IN A PERCH SPECIES.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Oekologische Chemie.
A. E. El Arab, A. Attar, L. Ballhorn, D. Freitag, and F. Korte.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 193-199, 1990. 3 fig, 2 tab, 9 ref.

Descriptors: *Acaricides, *Bioaccumulation, *Biodegradation, *Diazinon, *Fate of pollutants, *Insecticides, *Organophosphorus pesticides, *Path of pollutants, *Perch, Agricultural runoff, Agronomic crops, Carbon radioisotopes, Egypt, Fish, Fish physiology, Gas chromatography, High performance liquid chromatography, Mass spectrometry, Metabolism, Radioactive tracers, Rice.

In Egypt and other countries of warmer climate, diazinon is a widely used insecticide in rice fields in which fish are kept for consumer use. To investigate the bioaccumulation and metabolism of diazinon and its metabolites in fresh water fish, a series of tests were conducted using 14C-labelled diazinon in perch (Sarotherodon galilaeus) which is found in Asia Minor and East Africa. The results of the investigation revealed that, compared to other lipophilic compounds such as DDT and Lindane, the bioaccumulation factor of diazinon was found to be lower by a factor of more than 10. The highest concentrations of diazinon and/or its metabolites were found in the vertebral cord and the lowest concentrations were found in muscle. It was likewise demonstrated that depletion of diazinon and its metabolites were fast. After three days only 9% of the original concentration remained in fish kept in clear water. The substance was readily metabolized mainly by cleavage of the phosphoric acid moiety of the molecule. Since depletion of diazinon from fish is fast, the results of these experiments suggest that living fish meant for human consumption should be kept in fresh water for a few days prior to use. (Korn-PTT)
W91-04256

FORMS OF METALS IN A SEDIMENT CORE OF A SEVERELY ACIDIFIED NORTHERN BLACK FOREST LAKE.
Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W91-04257

POLYCHLORINATED DIBENZOFURANS IN THE EDIBLE PORTION OF SELECTED FISH.
Food and Drug Administration, Washington, DC. Contaminants Chemistry Div.
A. M. Gardner, and K. D. White.
Chemosphere CMSHAF, Vol. 21, No. 1/2, p 215-222, 1990. 4 tab, 26 ref.

Descriptors: *Bioaccumulation, *Fish, *Furans, *Path of pollutants, *Polychlorinated biphenyls, Adsorbents, Analytical methods, Analytical techniques, Column chromatography, Gas chromatography, Incineration, Mass spectrometry, Pollutant identification.

Fillets of 35 fish were examined for parts-per-trillion (ppt) levels of Polychlorinated dibenzofurans (PCDFs). The fish were obtained from sites contaminated with industrial chemicals or contained known or suspected levels of PCBs. PCDFs were extracted and cleaned up by column chromatography on a series of modified silica gel, carbon, and alumina adsorbents. Selected-ion mass spectrometry following capillary gas chromatography was used for quantitation. The predominant PCDFs found were 2,3,7,8-tetrachlorodibenzofuran, which occurred in 12 fish at an average of 25 ppt (range 3-93 ppt), and 2,3,4,7,8-pentachlorodibenzofuran, which occurred in 14 fish at an average of 34 ppt (range 4-113 ppt). Other tri-, tetra-, penta-, hexa-, and heptachlorodibenzofurans were found with less frequency; all of these were tentatively identified as 2,4,6-substituted PCDFs, that is, they were chlorinated at the 2, 4, and 6 positions. PCDFs were not found in 17 fish (limit of detection in the range 1-15 ppt). None of the fish contained more than 150 ppt of PCDF congeners. Since the selection of these samples was deliberately biased toward areas of known PCDF contamination, it is unlikely that individual congeners of bio-incurred PCDFs currently exceed this level in fish fillets. (Korn-PTT)
W91-04258

POTENTIAL SIGNIFICANCE OF MICROBIAL ACTIVITY IN RADIOACTIVE WASTE DISPOSAL.
Nuclear Electric, Barnwood (England).
For primary bibliographic entry see Field 5E.
W91-04260

DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL WASTE IN SWITZERLAND: BASIC ASPECTS OF POTENTIAL RELEVANCE TO MICROBIAL EFFECTS.
Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle, Baden (Switzerland).
For primary bibliographic entry see Field 5E.
W91-04261

SWEDISH FINAL REPOSITORY AND THE POSSIBLE RISK OF INTERACTIONS BY MICROBIAL ACTIVITIES.
Foersvarets Forskningsanstalt, Umea (Sweden).
For primary bibliographic entry see Field 5E.
W91-04262

MICROBIAL ACTIVITY IN THE TERRESTRIAL SUBSURFACE.
Pennsylvania State Univ., University Park. Lab. of Soil Science.
J. P. Kaiser, and J. M. Bollag.
Experientia EXPEAM, Vol. 46, No. 8, p 797-806, August 15, 1990. 4 tab, 77 ref. Department of Energy, Subsurface Transport Program Grant DE-FG02-87 ER60556 and E. I. duPont de Nemours and Company Grant AX 0720809.

Descriptors: *Biodegradation, *Fate of pollutants, *Groundwater pollution, *Microbial degradation, *Microbiological studies, *Microorganisms, *Path of pollutants, *Reviews, *Water pollution sources, Aerobic bacteria, Anaerobic bacteria, Aquifers, Bacteria, Nutrients, Permeability, Soil chemistry.

The problem of groundwater protection was reviewed with respect to subsurface microbial activity. Although groundwater is more difficult to contamiate than surface water, leachates from toxic waste dumps and landfills can percolate into subsurface zones and contaminate groundwater. Prevailing conditions in the subsurface habitat such as nutrient availability, soil composition, redox potential, permeability and a variety of other factors can influence the microflora that flourish in a given environment. Microbial diversity varies between geological formations, but, in general, sandy soils support growth better than soils rich in clay. Bacteria predominate in subsurface sediments, while eukaryotes constitute only 1-2 % of the microorganisms. Recent investigations revealed that most uncontaminated subsurface soils support the growth of aerobic heteroorganotrophic bacteria, but, obviously, anaerobic microorganisms also exist in the deeper subsurface habitat. The microorganisms residing below the surface of the earth are capable of degrading both natural and xenobiotic contaminants and can thereby adapt to growth under polluted conditions. (Korn-PTT)
W91-04263

PORE-WATER GEOCHEMISTRY AND THE MINERALOGY OF THE VADOSE ZONE OF SULFIDE TAILINGS, WAITE AMULET, QUEBEC, CANADA.
Waterloo Centre for Groundwater Research (Ontario).
D. W. Blowes, and J. L. Jambor.
Applied Geochemistry APPGEY, Vol. 5, No. 3, p 327-346, April/June 1990. 11 fig, 6 tab, 43 ref.

Descriptors: *Acid mine drainage, *Canada, *Geochemistry, *Groundwater chemistry, *Interstitial water, *Mine wastes, *Mineralogy, *Path of pollutants, *Quebec, *Sulfides, *Vadose zone, *Water pollution sources, Acid neutralization, Adsorption-coprecipitation reactions, Chemical analysis, Chemical composition, Chemical interactions, Copper, Crystal-structural replacement, Dissolved solids, Hydrogen ion concentration, Metals, Oxidation, Precipitation-dissolution reactions, Secondary mineral phases, Solubility, Zinc, Zones.

Low-pH waters, requiring treatment because of high concentrations of dissolved metals, are being discharged from a decommissioned tailings impoundment at the former Waite Amulet Zn-Cu mine in northeastern Quebec, Canada. A detailed study of the vadose zone of the tailings comparing mineralogical and geochemical analyses of the tailings solids with geochemical analysis of the tailings pore water and pore gas indicates the presence of three zones within the tailings. These zones include an upper sulfide-depleted zone in which the sulfides have been extensively removed and oxidation is largely complete, an intermediated zone, where sulfide oxidation and acid neutralization reactions are occurring, and an unoxidized zone below the depth of oxygen penetration, where sulfides are unoxidized. High aqueous concentrations of dissolved solids are being displaced downward from the sulfide-depleted zone, through the unoxidized zone toward the water table. Sulfide-oxidation and acid neutralization reactions have generated concentrations of dissolved solids high enough to lead to the precipitation of a series of secondary solid phases. Precipitation-dissolution reactions involving these solid phases control the concentrations of the major ions in the tailings pore water. Concentrations of dissolved metals are controlled by precipitation-dissolution, crystal-structural replacement, and adsorption/coprecipitation reactions. Predictions based on the observed data and numerical simulations suggest that, in the absence of an effective remedial program, sulfide oxidation and H(+) production will continue for several centuries. (Author's abstract)
W91-04271

PARAMETRIC STUDY OF DIETHYL PHTHALATE BIODEGRADATION.

Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
G. Zhang, and K. F. Reardon.
Biotechnology Letters BILED3, Vol. 12, No. 9, p 639-704, September 1990. 7 fig, 2 tab, 8 ref.

Descriptors: *Biodegradation, *Bioremediation, *Decontamination, *Fate of pollutants, *Microorganisms, *Phthalates, Aerobic bacteria, Aerobic conditions, Aerobic digestion, Anaerobic conditions, Anaerobic digestion, Biotechnology, Diethyl phthalate, Dissolved oxygen, Facultative microorganisms, Nutrients, Soil contamination, Wastewater treatment.

Phthalic acid esters, used primarily as plasticizers, are nearly ubiquitous soil and water contaminants. As a first step in a project on soil bioremediation, the effects of several environmental factors (i.e., temperature, initial primary substrate concentration, secondary substrates and organic and inorganic nutrients, and dissolved oxygen) on the biodegradation of diethyl phthalate (DEP) under aerobic and anaerobic conditions were investigated. Both aerobic and facultative DEP-degrading microorganisms were isolated from wastewater treatment plant sludge to be used in a series of shake flask and fermenter experiments. In a series of tests performed to evaluate the effects of the initial DEP concentration on DEP degradation it was found that the aerobic strains exhibited extended lag times at higher DEP concentrations. However, once the degradation started, its rate was not inhibited. Under anaerobic conditions, no extended lag times were seen. The results of a second series of tests conducted to investigate the effects of medium components and alternative substrates indicate that yeast extract promoted cell growth but inhibited DEP degradation in the aerobic strains, while dextrose and ethanol addition slowed the rate of degradation slightly. The same tests performed with the facultative strains showed that the addition of yeast extract, dextrose, or ethanol resulted in lower degradation rates, but casamino acids were found to increase the rate of DEP breakdown to a large degree. For a third series of tests, it was determined that low dissolved oxygen levels decreased the rate of DEP degradation. Finally, it was determined that the aerobic strains degraded best in a temperature range of 15 and 25 C, while the facultative strains appear to have an optimum near 15 C. (Korn-PTT)
W91-04274

QUALITY ASSURANCE/QUALITY CONTROL ASSESSMENT FOR A COLLABORATIVE STUDY OF 2,3,7,8-TCDD BIOACCUMULATION IN LAKE ONTARIO.

New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
P. O'Keefe, L. Wilson, C. Buckingham, and L. Raffert.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1277-1284, 1990. 1, fig, 5 tab, 2 ref. NYSDEC Contract No. C001880.

Descriptors: *Bioaccumulation, *Data quality control, *Dioxins, *Halogenated compounds, *Laboratory methods, *Lake Ontario, *Path of pollutants, *Pollutant identification, *Quality control, Analytical techniques, Data analysis, Fish, Interagency cooperation, Precision, Sediment analysis, Tissue analysis, Trout, Water analysis.

A collaborative study of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) bioaccumulation in Lake Ontario was carried out by the U. S. Environmental Protection Agency (EPA) and the New York State Department of Health (NYSDOH). There were two major parts of the study which included: (1) laboratory uptake and depuration experiments using lake trout as the test organism and (2) field measurements of 2,3,7,8-TCDD in five species of fish and in sediments. The total number of samples of fish tissue, fish food, water and sediment analyzed in the study exceeded 500. The most extensive quality assurance/quality control (QA/QC) procedures were associated with 2,3,7,8-TCDD determinations in fish and sediments. However, QA/QC data were also obtained for 2,3,7,8-TCDD determinations in fish food and water from the laboratory exposure study, lipid determinations in fish and for measurements of particle size, radionuclide and total organic carbon concentration in sediments. The results of the study revealed that, with the exception of the results from one of the fish samples from both the field and the laboratory studies, the QA/QC check sample results were within the accuracy criterion of the study (i.e. 50%). There was a trend of increasing accuracy at higher concentration levels and at concentrations greater than 5 picograms/gram; results from the laboratory and field studies showed maximum accuracy deviations of less than 18% and 34%, respectively. For the second half of the QA/QC program, field and laboratory samples were analyzed by the laboratories of the two different participating agencies. For five of the six samples (80%) where both laboratories obtained positive results, there was a maximum deviation between the laboratories of 35%. (Korn-PTT)
W91-04277

MONITORING DIOXINS AND DIBENZOFURANS IN PRECIPITATION IN ONTARIO.

Ontario Ministry of the Environment, Toronto. Air Resources Branch.
N. W. Reid, D. B. Orr, M. N. Shackleton, M. A. Lusis, and C. Tashiro.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1467-1472, 1990. 2 tab, 2 ref.

Descriptors: *Analytical methods, *Chemistry of precipitation, *Dioxins, *Furans, *Halogenated compounds, *Monitoring, *Ontario, *Pollutant identification, *Water analysis, Atmospheric deposition, Mass spectrometry, Path of pollutants, Precipitation, Rural areas, Sampling, Seasonal variation, Urban areas.

The concentrations of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in precipitation were monitored at both an urban and a rural location in Ontario as part of a monitoring program. A wet-only collector was used to collect the precipitation in a cleaned glass jug. The sampling period was 28 days. Solvent extracts of the samples were analyzed using mass spectrometry. The results of the monitoring investigation revealed that the concentrations of PCDD and PCDF in precipitation in Ontario were very low. The most prevalent isomer was octa-PCDD, which was detected more frequently and at higher concentrations, in precipitation samples collected at the rural site. The highest levels of octa-PCDD at the rural site tended to occur in the winter, and so may be associated with the burning of wood. The sensitivity of the method was significantly improved by doubling the sampling period to 56 days and by using high resolution mass spectrometry. (Korn-PTT)
W91-04288

RESULTS FROM THE FIRST YEAR OF THE SWEDISH DIOXIN SURVEY.

National Swedish Environment Protection Board, Solna.
C. deWit, B. Jansson, M. Strandell, P. Jonsson, and P. A. Berggvist.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1473-1480, 1990. 3 fig, 2 tab, 11 ref.

Descriptors: *Animal tissues, *Data collections, *Dioxins, *Foods, *Halogenated compounds, *Leachates, *Path of pollutants, *Sediments, *Surveys, *Sweden, *Swedish Dioxin Survey, Baltic Sea, Biological samples, Chemical analysis, Furans, Herring, Moose, Muscle, Water pollution sources, Wolf.

The Swedish Environmental Protection Agency is currently carrying out a three-year survey of the levels and sources of polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and other dioxin-like substances in the environment. During the first year, approximately 200 samples were analyzed. Biological samples included in the survey were food, raw and fried herring, wolf muscle, moose tallow, and burbot livers. A sediment core was also taken from the Baltic Sea and leach water samples were obtained from three garbage dumps. Results of the sampling survey revealed that the levels of PCDD and PCDF were at or below detection limits in the food. This made estimates of the average weekly dietary intake of PCDDs and PCDFs difficult to calculate. The results of the survey for herring samples revealed that, on a lipid weight basis, the concentrations of PCDD/F in herring were similar in both raw and fried herring. A determination of the PCDD/F levels in moose tallow revealed that they had lower PCDD/F levels than wolf muscle samples obtained from the same area. An analysis of the levels of PCDD/F in burbot liver samples showed them to be much higher near industrial discharges than in a more undisturbed area. The concentrations of PCDD/F for sediment samples revealed that the top 4 cm of the core contained the highest levels of PCDD/F. Thereafter, the levels dropped and reached a low level indicating contamination during sampling and not the presence of PCDD/F. An analysis of leach water from city dumps revealed low levels of PCDD/F but a leachate analysis from an industrial dump showed higher levels and a different congener pattern. (See also W91-04290 and W91-04291) (Korn-PTT)
W91-04289

ANALYSIS OF NON-ORTHO POLYCHLORINATED BIPHENYLS AND POLYCHLORINATED NAPHTHALENES IN SWEDISH DIOXIN SURVEY SAMPLES.

National Swedish Environment Protection Board, Solna. Special Analytical Lab.
L. Asplund, A. K. Grafstrom, P. Haglund, B. Jansson, and U. Jarnberg.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1481-1488, 1990. 5 fig, 2 tab, 12 ref.

Descriptors: *Fish, *Halogenated compounds, *Naphthalenes, *Path of pollutants, *Pollutant identification, *Polychlorinated biphenyls, *Sediments, *Sweden, *Swedish Dioxin Survey, Baltic Sea, Bioaccumulation, Biological samples, Chemical analysis, Cod, Data collections, Dioxins, Furans, Herring, Lipids, Metabolism, Pike, Polychlorinated naphthalenes, Pulp and paper industry, Seasonal variation, Sediment analysis, Toxicity.

The coplanar (non-ortho) polychlorinated biphenyls (pPCB), polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF), and polychlorinated naphthalenes (PCN) show high levels of biological activity and are being analyzed as part of the Swedish Dioxin Survey. This report presents the results obtained from an

analysis of pPCB and PCN levels in biological (herring, pike, cod) and sediment samples. The results of the investigation revealed that the predominant congeners found in biological samples were 3,3',4',4'-tetrachlorobiphenyl, 3,3',4,4',5-pentachlorobiphenyl, two early eluting pentachloronaphthalenes, and one early eluting hexachloronaphthalene. Baltic herring showed seasonal differences in pPCB and PCN levels. The lipid weight levels in cod muscle and liver were very similar despite differences in fat content. Pike and sediment from a PCB-contaminated river contained very high levels of pPCB and PCN but had PCDD and PCDF levels that were not unusually high. There were differences in the levels and isomer pattern between the sediment and pike indicating metabolism and bioaccumulation. There was a significant correlation between total and planar PCB content in herring and cod samples. The toxic potential of pPCB in most of the fish samples was found to be more than equal to that of PCDD/F. (See W91-04289 thru W91-04291) (Author's abstract)
W91-04290

LEVELS AND POSSIBLE SOURCES OF PCDD/PCDF IN SEDIMENT AND PIKE SAMPLES FROM SWEDISH LAKES AND RIVERS-PART ONE.
Umea Univ. (Sweden). Dept. of Environmental Chemistry.
L. O. Kjeller, S. E. Kulp, S. Bergek, M. Bostrom, and P. A. Bergquist.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1489-1496, 1990. 4 fig, 2 tab, 11 ref.

Descriptors: *Dioxins, *Furans, *Halogenated compounds, *Lakes, *Path of pollutants, *Pike, *Rivers, *Sediments, *Sweden, *Water pollution sources, Air pollution effects, Chemical analysis, Data collections, Effluents, Industrial wastes, Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans, Pulp and paper industry, Sediment analysis, Statistical analysis, Swedish Dioxin Survey.

One goal of the Swedish Dioxin Survey is to determine the levels of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in sediment and pike from contaminated and uncontaminated Swedish lakes and to identify the contamination sources. For the current study, a total of 16 samples of bottom sediment were collected along the coast line of two lakes and one river near different types of industries. Pike muscle samples were composites of 2-5 individuals. A multivariate statistical analysis was performed on the data generated in this investigation. The results of the investigation showed background levels of PCDD/F in some lakes which could only be explained by atmospheric input. In some lakes, paper mill emissions of chlorinated PCDD/F gave high levels of local contamination within short distances (<1 km) from the source. PCDD/F from paper mill effluents were transported long distances and traces could be detected over the entire lake area. The PCDD/F levels in pike were correlated with levels in the underlying sediment. (See W91-04289 thru W91-04290) (Author's abstract)
W91-04291

ANALYSIS OF DATED SEDIMENT SAMPLES FROM THE NEWARK BAY AREA FOR SELECTED PCDD/FS.
Nebraska Univ.-Lincoln. Dept. of Chemistry.
H. Y. Tong, S. J. Monson, M. L. Gross, R. F. Bopp, and H. J. Simpson.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1497-1502, 1990. 1 fig, 3 tab, 7 ref. NJDEP Contracts P24096 and P50582, Hudson River Foundation Grant HUD/015/86B/001, and NSF Grant CHE-8620177.

Descriptors: *Dioxins, *Estuaries, *Furans, *Halogenated compounds, *New Jersey, *Newark Bay, *Sediment analysis, *Sediments, *Water pollution sources, Chemical wastes, Fish, High resolution gas chromatography, High resolution mass spectrometry, New York Harbor, Passaic River, Pollutant identification, Radioactive dating, Tetrachlorodibenzo-p-dioxins.

In 1983, several species of fish from Newark Bay, New Jersey, and contiguous waters were reported to contain levels of 2,3,7,8-tetrachlorodibenzo-p-dioxins (TCDD) in excess of the U. S. Environmental Protection Agency (EPA) 'no consumption' level of 50 ppt. A possible source of this TCDD contamination has been a chemical manufacturing plant which synthesized 2,4,5-T from 1948-1969. It is well known that the highly toxic 2,3,7,8-TCDD is an unwanted impurity in 2,4,5-T. Soils from the plant were found to be highly contaminated with 2,3,7,8-TCDD. This chemical manufacturing plant is located on the Passaic River, approximately 3 km upstream of Newark Bay. To assess the magnitude and extent of 2,3,7,8-tetrachlorodibenzo-p-dioxins (TCDD) contamination, sediment cores from the Newark Bay estuary and contiguous waters (i.e., Passaic River and New York harbor) were collected and dated by radiochemical methods. The core sections from two time horizons were analyzed for selected polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) using high resolution gas chromatography (HRGC)/high resolution mass spectrometry (HRMS). The analysis of sediment core samples from the Newark Bay and Passaic River near the plant were characterized by a predominance of 2,3,7,8-TCDD. The results of the investigation indicate that the production of 2,4,5-T at the chemical manufacturing plant was a significant source of the 2,3,7,8-TCDD contamination in the Newark Bay and contiguous waters. (Korn-PTT)
W91-04292

ESTIMATION OF THE ENVIRONMENTAL FATE OF PCDD EMITTED FROM MUNICIPAL SOLID WASTE INCINERATORS.
Kyoto Univ. (Japan). Dept. of Environmental and Sanitary Engineering.
M. Hiraoka, N. Takeda, and S. Okajima.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1575-1580, 1990. 5 fig, 2 tab, 6 ref.

Descriptors: *Air pollution effects, *Dioxins, *Halogenated compounds, *Incineration, *Model studies, *Municipal wastes, *Path of pollutants, Japan, Runoff, Sediment contamination, Wastewater disposal, Water pollution sources, Wet deposition.

In Japan polychlorinated-p-dioxins (PCDDs) have been detected in air, seawater, river water, sediment, and biota. Municipal solid-waste incinerators are a major source of these pollutants. Japanese emission data were collected and analyzed to estimate the release of PCDDs into the environment from municipal incinerators. A compartmental model was used to calculate the environmental concentration of the released PCDDs and the predicted concentrations were then compared with observed concentrations. The model consists of six compartments: (1) air (gas), (2) air (aerosols), (3) water (dissolved matter), (4) water (suspended solids), (5) water (sediments), and (6) soil. The predicted concentrations in the sediment compartment seemed too small compared with the observed ones. The difference may indicate that stack emissions and leaching from fly ash in landfill sites do not significantly affect the sediment compartment. The data suggest that the model should include wastewater effluent sources and other transfer paths, such as wet deposition and transport of soil particles by runoff. (Shidler-PTT)
W91-04294

NUMERICAL METHOD FOR PARAMETERIZATION OF ATMOSPHERIC CHEMISTRY: COMPUTATION OF TROPOSPHERIC OH.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
For primary bibliographic entry see Field 2K.
W91-04299

TROPOSPHERIC OH IN A THREE-DIMENSIONAL CHEMICAL TRACER MODEL: AN ASSESSMENT BASED ON OBSERVATIONS OF CH3CCL3.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
C. M. Spivakovsky, R. Yevich, J. A. Logan, S. C. Wofsy, and M. B. McElroy.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 11, p 18,441-18,471, October 20, 1990. 31 fig, 10 tab, 90 ref, 2 append. NASA GrantGrant NAG5-719, NSF Grant ATM84-13153, EPA Grant R814535010.

Descriptors: *Atmospheric chemistry, *Environmental tracers, *Mathematical models, *Path of pollutants, *Trichloroethane, Chlorinated hydrocarbons, Computer models, Global distribution, Hydroxyl radicals, Model studies.

The three-dimensional global distribution of OH over a year was calculated as a function of temperature, ultraviolet irradiance, and densities of water, carbon dioxide, ozone, methane and nitrogen oxides. The concentration of OH was computed within a chemical tracer model (CTM) with an accuracy comparable to that of a detailed photochemical model. The CTM was used to simulate the global distribution of trichloroethane (TCE). The computed distribution of OH implies a lifetime of 5.5 years for TCE. Analysis of the long-term trend in TCE as defined by observations suggests a lifetime of 6.2 years, indicating that model levels of OH may be too high by about 13%. This estimate for the lifetime depends on industry data for global emissions and on the absolute calibration of observations. It is argued that seasonal variations of TCE provide an independent test for computed OH fields that is insensitive to the uncertainties in the budget of TCE. The annual cycle of TCE from about 25 degrees S to the South Pole is dominated by seasonal changes in OH. Observed seasonal variations of TCE indicate that the OH field south of 20 +/-4 deg S should be scaled by 0.75 +/-0.25 from computed values, consistent with the result based on long-term trends. If use of TCE is phased out (as envisioned by the Montreal protocol), the dynamically driven seasonal variations of TCE will decrease dramatically, whereas the chemically driven variations will remain proportional to the concentration of TCE; then the annual cycle in northern mid-latitudes will provide a measure of OH as does at present the annual cycle in southern mid-latitudes. If emissions of TCE were to cease, the tropical depression in the concentration of TCE caused by high levels of OH in the tropics may provide an additional means to test OH models. (See also W91-04299) (Author's abstract)
W91-04300

SMOG-FOG-SMOG CYCLE AND ACID DEPOSITION.
California Inst. of Tech., Pasadena. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 2K.
W91-04301

ONE-DIMENSIONAL NUMERICAL MODEL TO SIMULATE FORMATION AND BALANCE OF SULFATE DURING RADIATION FOG EVENTS.
Munich Univ. (Germany, F.R.). Meteorologisches Inst.
For primary bibliographic entry see Field 2K.
W91-04302

TIME-LINE INTERPOLATION FOR SOLUTION OF THE DISPERSION EQUATION.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
J. C. Yang, and E. L. Hsu.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 503-520, 1990. 6 fig, 13 ref, append.

Descriptors: *Advection, *Diffusion, *Dispersion, *Dispersion equation, *Finite difference methods, *Mathematical analysis, *Model studies, *Path of pollutants, Courant number, Simulation analysis, Temporal interpolation.

Among all finite difference schemes for solving the advection portion of the dispersion equation, the Holly-Preissman's two-point method (H-P method) introduces the least numerical damping and phase errors. The key of this method is the use of a cubic interpolating polynomial for searching the charac-

teristic trajectory on the spatial axis. This polynomial is constructed with the use of parameters including dependent variables and their space derivatives for two grid points on the spatial axis. A new interpolation technique has been constructed following a similar idea, which uses the dependent variables and their temporal derivatives for two points on the time axis as the parameters for the polynomial. Through the error analyses performed on the numerical damping and phase errors for the linear advection equation, it has been observed that this new technique gives a more accurate solution than the H-P method. A simple hypothetical model was constructed to demonstrate the merits of the new technique. For the pure advection and advection-diffusion problems, based on the simulations demonstrated, the newly proposed temporal interpolation technique gives better results when the Courant number is less than 1.0. (Author's abstract)
W91-04309

GASOLINE LEAD IN WEST GERMAN SOILS.
Heidelberg Univ. (Germany, F.R.). Inst. fuer Umweltphysik.
H. Dorr, K. O. Munnich, A. Mangini, and W. Schmitz.
Naturwissenschaften NATWAY, Vol. 77, No. 9, p 428-430, September 1990. 3 fig, 1 tab, 10 ref. State Government of Baden-Wurttemberg Grant PW 87060.

Descriptors: *Air pollution, *Gasoline, *Germany, *Lead, *Path of pollutants, *Soil contamination, Air pollution sources, Environmental quality, Frankfurt, Lake sediments, Mass balance, Pollution load.

A simplified mass balance of atmospheric lead in West Germany was presented. Gasoline lead since 1950 was found to be distributed rather homogeneously over the entire country, stored in the top 20 cm of the soil. The average anthropogenic lead inventories were 10.8, 3.4, and 1.4 g/sq m at urban, semi-urban and rural sites, respectively. To check the assumption that the source of the observed anthropogenic lead in soils is the burning of leaded gasoline, the atmospheric gasoline lead input function was reconstructed for West Germany. A good correlation was observed between the annual mean atmospheric lead content and gasoline lead exhaust in West Germany for the period 1972-1986. In the city and in the suburbs of Frankfurt (ca. 1 million inhabitants) the local lead source density was more than ten times higher than the country-wide average. The validity of the reconstructed gasoline lead input function was also suggested by lead concentration profiles observed in lake sediments in southern Germany showing a pronounced lead concentration maximum at a sediment depth representing the year 1970. The measured soil lead inventories at all sites so far investigated were found to be slightly higher than expected from the atmospheric input function. This is probably due to a more efficient removal of lead from the atmosphere at forested sampling sites. It is concluded that a reduction of gasoline lead emission will considerably improve air and food quality in West Germany, while the lead contamination of mushrooms and plants by uptake from the soil will remain at the present level for the next century. (MacKeen-PTT)
W91-04310

FACTORS INFLUENCING THE CHEMICAL CHARACTERISTICS OF LANDFILL LEACHATES.
Ross Consultancy, Tygerpark (South Africa).
W. R. Ross.
Water SA WASADV, Vol. 16, No. 4, p 275-280, October 1990. 4 fig, 2 tab, 15 ref.

Descriptors: *Landfills, *Leachates, *Path of pollutants, *Sanitary landfills, *Solid waste disposal, *Water pollution sources, Biodegradation, Cape Town, Chemical oxygen demand, Coastal Park landfill site, Decomposing organic matter, Dissolved solids, Metals, Nitrogen compounds, South Africa, Sulfates.

The stabilization of municipal refuse in sanitary landfills gives rise to leachates which are often highly polluted. Leachate data obtained from the Coastal Park landfill site near Cape Town were used to illustrate the stabilization process and naturally occurring decomposition phases of the refuse mass. The total dissolved solids concentration indicated that the leachate was originally markedly saline. The chemical oxygen demand (COD) value provides a good approximation of organics in the leachate. The COD of the Coastal Park landfill Cell No. 1 reached a peak value of 56 g/L after 1 y, decreasing to 2 g/L by the third year. The ammonia-N concentration was still fairly high (1,340 mg/L) after 42 months of stabilization, indicating continuing decomposition of organic nitrogen in the refuse mass. The presence of oxidized forms of nitrogen in the leachate indicated that nitrification of ammonia had taken place. The leachate pH was below 6 during the acid formation phase and had increased to above 7.5 at 30 mo. A decrease in sulfate concentration from 886 mg/L initially to 37 mg/L after 42 mo indicated the presence of sulfate reducing bacteria. High concentrations of toxic metals after 5 mo may inhibit the biological activity of the refuse mass. It is concluded that the chemical composition of the leachate from the Coastal Park landfill site is similar to that reported for other 'young' landfill sites. Due to the pollution hazard of landfill leachates, an integrated sewage and refuse treatment system is recommended. (MacKeen-PTT)
W91-04319

BIOACCUMULATION OF SELECTED HEAVY METALS BY THE WATER FERN, AZOLLA FILICULOIDES LAM. IN A WETLAND ECOSYSTEM AFFECTED BY SEWAGE, MINE AND INDUSTRIAL POLLUTION.
Rand Afrikaans Univ., Johannesburg (South Africa). Dept. of Zoology.
L. P. D. de Wet, H. J. Schoonbee, J. Pretorius, and L. M. Bezuidenhout.
Water SA WASADV, Vol. 16, No. 4, p 281-286, October 1990. 1 fig, 3 tab, 46 ref.

Descriptors: *Aquatic plants, *Bioaccumulation, *Heavy metals, *Path of pollutants, *South Africa, *Wastewater treatment, *Water fern, *Wetland treatment, *Wetland waste treatment, Blesbok Spruit wetlands, Chromium, Copper, Industrial wastes, Iron, Lead, Manganese, Mine wastes, Nickel, Transvaal, Wastewater pollution, Water pollution, Water pollution treatment, Wetlands, Zinc.

The bioaccumulation of the heavy metals Fe, Cu, Ni, Pb, Zn, Mn and Cr by the water fern Azolla filiculoides Lam. in a polluted wetland ecosystem was investigated. The Blesbok Spruit wetlands, Transvaal, has received effluents and seepage waters from surrounding mines and industries as well as discharges of treated sewage effluent for the past 80 y. The sequence of heavy metals from the sediments at four localities in the wetlands was, in descending order of concentration: Fe>Zn>Mn>Ni>Cr>Cu>Pb. Extremely high values of iron occurred in the sediments at all four locations (7,528-59,598 mg/g). The metals reaching the highest concentration levels in A. filiculoides were Fe and Mn. In terms of bioaccumulation factor, Mn was best absorbed (2,065%) followed by Pb (607%), Ni (85%), and Cu (70%). It is concluded that if an active cropping program of A. filiculoides can take place throughout the year, substantial quantities of heavy metals can be removed with the plant material from the aquatic environment. (MacKeen-PTT)
W91-04320

DEVELOPMENT OF A METHODOLOGY TO DETERMINE THE POLLUTION DISCHARGED BY A COMBINED SEWER NETWORK.
Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Dept. Genie Civil et Urbanisme.
M. Cherrered, and B. Chocat.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 15-22, 1990.8 fig, 1 tab, 3 ref.

Descriptors: *Combined sewer overflows, *France, *Storm water, *Urban runoff, *Water pollution sources, Case studies, Computer models, Environmental impact, Urban hydrology, Water pollution effects, Water quality management.

Until a few years ago, there was not much research in France into combined sewer overflow phenomena in storm weather. Urban runoff water has always been considered 'clean' and it was considered that the dilution of dry weather flows in storm water decreased the impact of pollution generated by overflows. With increased urban development and realization of the importance of pollution caused by urban runoff, some quality studies of receiving waters show that combined sewer networks represent an important pollution source for the natural environment, due to the increasing relative effect of combined sewer overflow discharge into receiving waters. Thus, combined sewer overflows have until recently been the least known part of the sewer system. Methodology to estimate combined overflows has been developed after evaluation of data result from ten French real case studies where such problems were observed. This study has been realized in four steps: (1) a bibliography study to discover the actual state of the problem in terms of existent methods concerning both experimentation and modeling and to define research needs; (2) ten French studies have been selected, analyzed, used to define the different methods used, and to show methodological lacunas from the observations and results, and to propose elements of improvement; (3) methods and new propositions have been defined and a coherent methodological diagram has been developed to compare and test these methods; and (4) computer tools have been conceived and tested in the ten study cases. The tests are being carried out and some results have been obtained, but will not be published until complete. (Author's abstract)
W91-04324

EVALUATION OF POLLUTANT LOADS FROM URBAN NONPOINT SOURCES.
National Water Research Inst., Burlington (Ontario).
J. Marsalek.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 23-30, 1990. 1 fig, 2 tab, 23 ref.

Descriptors: *Nonpoint pollution sources, *Storm water, *Urban hydrology, *Urban runoff, *Water pollution effects, *Water pollution sources, Databases, Great Lakes, Statistical analysis.

In preparation of remedial action plans for areas of environmental concern in the Great Lakes Basin, the magnitude of pollutant contributions from point as well as nonpoint sources needs to be assessed. For screening evaluations of urban nonpoint source pollution, a statistically-based method was applied in one of the areas of concern. This method computes the annual pollutant load as a product of the annual runoff and the mean pollutant concentration derived from a lognormal distribution of concentrations. Approximate confidence intervals can be determined for the mean concentration and used to compute confidence intervals of the loads. For common constituents, this methodology yields results consistent with those obtained from general storm water quality databases. For uncommon constituents (e.g., toxic trace substances), the utility of general databases diminishes, as strong local sources may control the loads. Application of this screening procedure in the Upper Great Lakes Connecting Channels area showed that, for most constituents, the point sources controlled the overall loads discharged to the receiving waters. The attainment of water quality objectives in the receiving waters required pollution control orders for seven constituents. For most constituents with significant runoff loads, storm water may require dilutions up to 50 times to meet the ambient water quality objectives and such dilutions are generally available. (Fish-PTT)
W91-04325

COMPARISON OF OVERFLOWS FROM SEPARATE AND COMBINED SEWERS--QUANTITY AND QUALITY.

University of Technology Sydney, Broadway (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04326

QUALITY OF SEWAGE FLOWS AND SEDIMENT IN DUNDEE.
Dundee Inst. of Tech. (Scotland). Dept. of Civil Engineering, Surveying and Building.
R. M. Ashley, B. P. Coghlan, and C. Jefferies.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 39-46, 1990. 11 fig, 2 tab, 6 ref.

Descriptors: *Combined sewer overflows, *Dundee, *Mass balance, *Pollutant load, *Scotland, *Sediment transport, *Sewer systems, *Solute transport, *Storm runoff, *Storm water, *Urban runoff, Chemical properties, Deposition, Erosion, Sewer hydraulics, Storm sewers, Storm wastewater, Suspended sediments, Urban hydrology, Water pollution effects.

Interrelated studies are underway in Dundee, Scotland, to investigate the nature, origins, disposition, and movements of sewer sediments and associated pollutants. These studies have provided support for a proposed subjective classification system for combined sewer sediments based on visual appearance, occurrence, and polluting strength. Data obtained from samples of suspended sediments at either end of a 175-m length of the main Dundee sewer during dry weather and storm flows have been used to carry out a mass balance for the length over a one-month period. It was found that there is a much greater variability in the chemical characteristics between the two sampling points, and it can therefore be concluded that in this length of sewer there is a degree of uniformity in the transport of suspended sediments, whereas the dissolved pollutants are more spatially variable. There is no consistent pattern for erosion or deposition within the sewer length as a consequence of storm flows. Similar storms in terms of volume or intensity may result in a net erosion or deposition. Despite the obvious limitations, the results compare surprisingly well with the observed changes in the volume of bed deposits along the length for the same period. It may be concluded that this subjective sediment classification system is a viable basis for characterizing combined sewer sediments in terms of physical and chemical properties with regard to pollution loads and hydraulic constriction. (Fish-PTT)
W91-04327

MICROBIAL ASPECTS OF SEWAGE AND SEWAGE SLUDGE IN DUNDEE, SCOTLAND.
Dundee Inst. of Tech. (Scotland). Dept. of Civil Engineering, Surveying and Building.
C. Jefferies, H. K. Young, and I. McGregor.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 47-52, 1990. 4 fig, 2 tab, 7 ref.

Descriptors: *Combined sewer overflows, *Dundee, *Low flow, *Scotland, *Sewage bacteria, *Sewer systems, *Storm runoff, *Urban runoff, Daily variation, Fecal coliforms, Flow rates, Seasonal variation, Sludge analysis, Storm sewers, Storm water, Suspended solids, Urban hydrology.

Relatively little data are available on bacterial populations in combined sewer systems. Studies of the populations of coliforms and fecal streptococci in sewage and sewage sediments have been carried out in Dundee, Scotland. Samples were obtained and tested by standard methods from five storm and five dry weather flow events, in order to determine whether variations in the bacterial content of sewage effluent and sewer sediments could be correlated with parameters such as flow rate and time. It was concluded that such a correlation can be made for dry weather flows. A study of the dry weather flow bacteria data showed that deposition and erosion of in-sewer sediment can be inferred for different times of the day. Between 10.00 and 22.00 hrs, both flow and total suspended solids remained relatively constant. During this period, however, the total and fecal coliform counts reached peaks at different times, suggesting that during the first part of the period fresh sewage solids are being washed down but at later times the previously-deposited sediment bed is eroded. Between 10.00 and 22.00 hrs, the bed deposits accumulated. A daily variation for winter and spring conditions was observed. No consistent variation could be determined for the storm events studied. (Fish-PTT)
W91-04328

METAL SPECIATION IN SEPARATE STORMWATER SYSTEMS.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering.
G. M. P. Morrison, D. M. Revitt, and J. B. Ellis.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 53-60, 1990. 2 fig, 2 tab, 11 ref.

Descriptors: *Chemical speciation, *Heavy metals, *Path of pollutants, *Separated sewers, *Storm drains, *Storm sewers, *Storm water, Acid rain, Biological magnification, Cadmium, Copper, Dissolved solids, Environmental impact, Geochemistry, Gullies, Highway effects, Inorganic compounds, Ions, Iron, Lead, Metal complexes, Roads, Sewer separation, Speciation, Urban runoff, Zinc.

The evaluation of the controls on, and the impacts of, toxic heavy metals discharged to urban receiving waters by storm water runoff has received relatively little attention. Biogeochemical processes, affecting metal speciation in a gullypot system and at storm water outfalls, were investigated. Ionic lead and copper species released from road sediments by acid rain are scavenged by dissolved organic material and suspended solids as a result of a rise in pH through the road/gullypot system. Cadmium and zinc tend to remain in the dissolved phase. Bacterial activity and acid dissolution produce increases in dissolved metal in the gullypot liquor and it is these metals which contribute to the early storm profile. Metals in basal gullypot sediments are readily mobilized during high volume/intensity storms. The resulting storm water contains dissolved ionic forms of cadmium and zinc, while lead is mostly adsorbed to suspended solid surfaces. Copper also binds to solids, although approximately 50% is transported by dissolved organic material. For the separation of directly toxic metal species, anodic stripping voltammetry at polymer-coated electrodes is preferred. Lead and copper are present as iron/humic colloids and organic complexes respectively, which are not directly toxic to algae. Cadmium is predominantly ionic and inorganically complexed and therefore directly toxic. It is recommended that the highly toxic lipid soluble metal species should be analyzed in storm water. (Author's abstract)
W91-04329

DISTRIBUTION OF SEDIMENTATION RATES OF SUSPENDED SOLIDS AND HEAVY METALS IN COMBINED SEWER OVERFLOWS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
A. P. Benoist, and L. Lijklema.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 61-68, 1990. 5 fig, 2 tab, 9 ref.

Descriptors: *Combined sewer overflows, *Heavy metals, *Path of pollutants, *Sedimentation rates, *Sewer systems, *Storm water, *Suspended solids, *Urban runoff, *Water pollution sources, Discharge measurement, Hydrologic models, Lead, Pollution load, Water quality, Zinc.

Previous research on combined sewer overflows (CSOs) has shown that the suspended solids (SS) concentrations in overflowing waters are much higher than in those of effluents of sewage treatment plants. Hence CSOs are major contributors in the pollution load discharged into receiving waters. Measured absolute concentrations and the distributions of sedimentation rates (DSRs) of SS and heavy metals in CSOs show a strong variation between events. The load of SS discharged by CSOs exist for 30% to 50% of readily settleable particles; a large part of the load of SS will settle near the outlet. These variations can be explained partly by a relationship between the maximum discharge rate during an overflow and (a) the concentrations of SS and the heavy metals lead and zinc, and (b) the fraction of the DSR with high settling rates and the associated lead concentrations. However, no unambiguous relationship between the DSR for the SS concentrations and the associated heavy metal concentrations has been detected. In contrast to the general experience a specific association of heavy metals with the fine fraction (low settling rates) in the SS of CSOs has not been found. The measured DSRs of SS and heavy metals have been used as input to a receiving water quality model. The simulated response is satisfactory, with regard to SS concentrations but not for heavy metals. (Author's abstract)
W91-04330

LONG-TERM SIMULATION OF POLLUTANT LOADS IN TREATMENT PLANT EFFLUENTS AND COMBINED SEWER OVERFLOWS.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
A. Durchschlag.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 69-76, 1990. 7 fig, 1 ref.

Descriptors: *Combined sewer overflows, *Effluents, *Model studies, *Storm water, *Urban runoff, *Wastewater treatment, *Water pollution sources, Biological oxygen demand, Pollution load, Simulation analysis, Solute transport, Storage tanks, Storm-overflow sewers, Urban hydrology, Wastewater facilities, Wastewater pollution.

As a result of urbanization, the pollutant discharges from sources such as treatment plant effluents and polluted storm waters are responsible for an unacceptable water quality in the receiving waters. In particular, combined sewer system overflows may produce great damage due to a shock effect. To reduce these combined sewer overflow discharges, the most frequently-used method is to build storm water storage tanks. During storm water runoff, the hydraulic load of wastewater treatment plants increases with additional retention storage. This might decrease the treatment efficiency and thereby decrease the benefit of storm water storage tanks. The dynamic dependence between transport, storage, and treatment is usually not taken into account. This dependence must be accounted for when planning treatment plants and calculating storage capacities in order to minimize the total pollution load to the receiving waters. A numerical model has been developed that enables the biological oxygen demand discharges to be continuously calculated. The pollutant transport process within the networks and the purification process within the treatment plants were simulated. The results of the simulation illustrate a statistical balance of the efficiency of storm water tanks and the operation of combined sewer systems and treatment plants. (Author's abstract)
W91-04331

ESTIMATION OF STORM WATER QUALITY CHARACTERISTICS AND OVERFLOW LOADS FROM TREATMENT PLANT INFLUENT DATA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
R. H. Aalderink.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 77-85, 1990. 3 fig, 4 tab, 12 ref.

Descriptors: *Combined sewer overflows, *Model studies, *Storm sewers, *Storm water, *Urban hydrology, *Urban runoff, *Wastewater facilities, *Water pollution sources, *Water quality, Flow discharge, Influent water, Monte Carlo method, Pollution load, Simulation analysis, Water pollution effects.

A simple model, based on tanks in series, for the estimation of mean annual loads and frequency distributions of loads from combined sewer systems has been developed. The input data, dry weather flow, dry weather quality, and storm water quality are estimated from treatment plant influent data. Two similar methods for the estimation of flow-average storm water quality were tested by using treatment plant influent data gener-

ated by the model in comparison with the model input. Both methods are based on daily mass balances, but differ slightly with respect to the averaging procedures used. The performance of both methods is about the same. They show a small bias, but the variability introduced is small when compared with the variation occurring in real storm water quality data. Application of one of the methods on field data revealed no distinct relationships between the flow-averaged storm water quality concentration and the dry weather period or the total daily rain depth. By combination of continuous and Monte Carlo simulation techniques the model can be used to estimate mean annual loads and frequency distribution of loads from combined sewer overflows. For the extreme events a large 90% confidence interval was found due to the large variations in storm water quality. (Author's abstract)
W91-04332

COMBINED LONG-TERM SIMULATION OF RUNOFF FROM URBAN AND RURAL AREAS.
Addis Ababa Univ. (Ethiopia). Faculty of Technology.
M. W. Ostrowski, and L. Alsenz.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 87-94, 1990. 5 fig, 2 tab, 7 ref.

Descriptors: *Model studies, *Path of pollutants, *Rural areas, *Storm runoff, *Storm water management, *Urban hydrology, *Urban runoff, *Water pollution sources, *Water quality standards, Germany, Hydrologic models, Overflow, Simulation analysis.

It has become evident that emission control standards for storm water overflow design are practical, but not sufficient to guarantee ecologically-balanced quantity and quality characteristics of receiving natural water bodies. The quality and quantity of both storm water overflow and the receiving water should be considered at the same time. An continuous complex hydrological (quantity) model for simulating combined urban and rural runoff processes was applied to a small catchment in Northrhine-Westphalia, Germany, to get more information on its suitability as a modern planning tool. The frequency of the mixing characteristics of overflow and riverflow was determined by combined continuous long-term simulation to receive a quantitative emission criterion. By comparing runoff from an assumed natural watershed to different planning alternatives, measures could be identified for compensating human impacts to a considerable extent. In contrast to existing emission standards, the methodology provides knowledge of the magnitude and frequency of disturbance of natural flow in receiving water bodies; the application of standardized design rules for combined sewer systems should be replaced by the application of individual hydrological complex investigations. Data availability and computational efforts are suitable for general application. (Fish-PTT)
W91-04333

COMPARISON OF POLLUTANT LOAD CALCULATION METHODS BASED ON MEASURED DATA--STATE OF THE INVESTIGATION.
Landesamt fuer Wasser und Abfall Nordrhein-Westfalen, Duesseldorf (Germany, F.R.).
H.-J. Russ, and M. Uhl.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 95-102, 1990. 3 fig, 1 tab, 4 ref.

Descriptors: *Model studies, *Pollution load, *Storm water, *Urban runoff, *Water pollution sources, Calibrations, Combined sewers, Comparison studies, Computer programs, Discharge measurement, Germany, Urban hydrology, Water pollution effects, Water quality.

An investigation is being carried out in North Rhine-Westphalia, Germany, to compare and evaluate different methods for the calculation of pollutant loads. The investigation consists of two parts: (1) measurements in the variously-configured combined sewer systems of two partial catchment areas to form the basis for the calculation comparisons and to obtain advanced knowledge of measurement techniques; and (2) comparison of 15 different pollutant load calculation methods, with and without calibration, for both the catchment areas. The measurement projects have been running successfully since 1987. The database for the model calibrations is available for one partial catchment. The comparison of the models without calibration has already been completed. Results obtained thus far show that too high confidence in the correctness of computer programs leads to neglect of simple checks of the results. The user's experience and qualifications substantially influences the quality of the results. The modeling of hydraulic substitution systems for discharge and storage systems is an important source of mistakes. Development of models must be accompanied by extensive tests and checks. Susceptibility to error increases with greater complexity of models. Variation of results is much greater relative to water quality than to quantity. For calibration and development of pollutant load calculation methods, good measured data is necessary. Calibration for practical purposes requires water quantity data in any case, and water quality data is desirable. The development of models cannot reduce the need for more water quality data. (Fish-PTT)
W91-04334

DEVELOPMENT, CALIBRATION AND FURTHER DATA REQUIREMENTS OF THE SEWER FLOW QUALITY MODEL MOSQITO.
Hydraulics Research Ltd., Wallingford (England).
J. A. Payne, G. D. Moys, C. J. Hutchings, and R. J. Henderson.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 103-109, 1990. 5 fig, 6 ref.

Descriptors: *MOSQITO Model, *Model studies, *Sewer systems, *Storm runoff, *Storm water, *Urban hydrology, *Urban runoff, *Water quality, Calibrations, Data requirements, Dispersion, England, Flow discharge, Sediment transport, Suspended solids.

MOSQITO (Modeling of Storm Quality Including Tank Overflows) is the initial version of a sewer flow quality model being developed as part of the U.K. River Basin Management program. MOSQITO I simulates the time-varying behavior of suspended solids, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, and hydrogen sulfide on catchment surfaces and in sewer systems. The model produces discharge pollutographs for these determinands which can be used as input to a river water quality model. MOSQITO consists of four submodels which represent washoff from catchment surfaces, foul water inflow, pollutant behavior in pipes and channels, and pollutant behavior in ancillary structures within drainage systems. Calibration and verification of the model are being carried our using data from a variety of experimental catchments in the U.K. Initial results indicate that suspended solids are underpredicted, possibly because the estimates of the calibration parameters are low, or sediment deposits were present in the system at the start of the monitored events and were eroded by the storm flows, thus increasing the mass of sediment discharged at the outfall. Dispersion was significant in sewers and therefore should be included in MOSQITO. The model will probably find most frequent practical application in sewerage rehabilitation studies and must therefore be capable of producing acceptable simulations of pollutant loading without extensive site-specific calibration. Work to date, on both separate and combined systems, indicates that MOSQITO will provide an effective tool for modeling a number of crucial water quality determinands in sewer systems. (Fish-PTT)
W91-04335

FLUXES OF OXYGEN EQUIVALENTS AND NUTRIENTS ACROSS THE SEDIMENT-WATER INTERFACE AFTER COMBINED SEWER OVERFLOWS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
L. Lijklema, A. F. M. Meuleman, and H. M. M. Bosgoed.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 111-118, 1990. 2 fig, 2 tab, 4 ref.

Descriptors: *Combined sewer overflows, *Nutrient transport, *Oxygen transfer, *Path of pollutants, *Sediment-water interfaces, *Storm water, *Urban runoff, Aerobic conditions, Anaerobic conditions, Chemical oxygen demand, Dissolved oxygen, Laboratory methods, Methane, Nitrogen, Particulate matter, Sediment load, Sewage sludge, Solute transport, Water pollution effects.

Immediate effects of (combined) sewer overflows are mainly due to the physical phenomena of flushing and scouring, and to the high-rate processes associated with the dissolved reactive compounds in the discharged water. Delayed and frequently prolonged consequences are predominantly due to particulate material in the overflow. The fluxes of oxygen into sediments and the release rate of chemical oxygen demand (COD), methane, and nitrogen after deposition of fresh sewage sludge were measured in an experimental laboratory apparatus. Effects of the initial surface loading revealed a progressive contribution of COD release to the flux of oxygen equivalent to increased loading. Lower oxygen concentrations had the same effect. The actual conversion rate of the organics in the sediments was lower than the potential maximal aerobic degradation rate and higher than the anaerobic rate of hydrolysis. Preferential oxidation of soluble organics at the sediment interface over particulate material limits the release of COD except for high-loaded systems or at low dissolved oxygen concentrations. (Fish-PTT)
W91-04336

STORM WATER RUNOFF OF HYDROCARBONS IN THE TAMA RIVER BASIN IN TOKYO (JAPAN) AND THEIR FATE IN THE RIVER.
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Chemical Engineering.
A. Yamane, I. Nagashima, T. Okubo, M. Okada, and A. Murakami.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 119-126, 1990. 6 fig, 1 tab, 24 ref.

Descriptors: *Aliphatic hydrocarbons, *Japan, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Storm runoff, *Storm water, *Urban runoff, *Water pollution sources, Dusts, Environmental impact, Fate of pollutants, Highway effects, Roads, Stream pollution, Suspended sediments, Urban hydrology, Water level.

Storm water runoff pollution in urban areas has a significant impact on the aquatic environment. The origin, transport, and fate of hydrocarbons in the Nogawa River, a typical urban river running through a residential area in suburban Tokyo, Japan, were studied at both normal and high water levels. It was concluded that aliphatic hydrocarbons found in the water of the Nogawa River during normal water levels originated mainly from gray water. Aliphatic hydrocarbons found during high water levels originated mainly from runoff water. They came from roadside dust or emissions from automobiles, and were washed off into storm water drains by storm water. The resuspension of sediment may also contribute to hydrocarbon levels during high water levels. Polycyclic aromatic hydrocarbon contents in roadside dust came from Route 20, which has heavy traffic, were the same as those in the street dust near the Nogawa River (an area with light traffic). Thus, automobile emissions were not the major source of polycyclic aromatic hydrocarbons. (Fish-PTT)
W91-04337

EVALUATION OF THE IMPACTS OF DISCHARGES FROM SURFACE WATER SEWER OUTFALLS.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 5C.
W91-04338

DISSOLVED OXYGEN STREAM MODEL FOR COMBINED SEWER OVERFLOWS.
Aalborg Universitetscenter (Denmark). Hydraulics

and Coastal Engineering Lab.
For primary bibliographic entry see Field 5C.
W91-04339

SEWER SEDIMENT AND ITS RELATION WITH THE QUALITY CHARACTERISTICS OF COMBINED SEWER FLOWS.
Universite Libre de Bruxelles (Belgium). Lab. de Traitement des Eaux et Pollution.
For primary bibliographic entry see Field 5D.
W91-04352

IMPACT OF OVERFLOW ON SURFACE WATER QUALITY IN EAST BRABANT, THE NETHERLANDS.
East Brabant Dept. of Technology, Boxtel (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04356

PARTITIONING OF UNSUBSTITUTED POLYCYCLIC AROMATIC HYDROCARBONS BETWEEN SURFACE SEDIMENTS AND THE WATER COLUMN IN THE BRISBANE RIVER ESTUARY.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
S. I. Kayal, and D. W. Connell.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 4, p 443-456, 1990. 5 tab, 3 fig, 28 ref.

Descriptors: *Estuarine sediments, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Water pollution, *Water sampling, Australia, Brisbane River Estuary, Chemical analysis, Partition coefficient, Pollutant identification, Sediment analysis, Sediment contamination.

Polycyclic aromatic hydrocarbons (PAHs) are among the most widely distributed groups of organic environmental pollutants. In all, 23 sediment samples and 8 water column samples from the Brisbane River estuary, Queensland, Australia, were analyzed for polycyclic aromatic hydrocarbons in order to assess the field partitioning behavior of these hydrocarbons. Twelve PAHs, ranging in molecular weight from naphthalene to benzo(a)pyrene, were identified and quantified. Their partition coefficients, indexed to sediment organic carbon and lipid content, were calculated after filtering to remove particulates and making a calculated adjustment for colloids, or organic matter, in the water phase. In logarithmic form, the partition coefficients were related to the physico-chemical properties of the compounds (octanol-to-water partition coefficient (K(ow), aqueous solubility, and gas chromatograph relative retention time) by relationships having a parabolic shape rather than being linear. However, compounds with log K(ow) values of less than 5.5 gave linear relationships comparable to, but distinctly different from those obtained from laboratory experiments. It is suggested that field conditions have distinctive differences from laboratory experiments that do not allow the direct translation of laboratory-based relationships to the natural aquatic environment. (Author's abstract)
W91-04361

GIARDIASIS OUTBREAK FROM A CHLORINATED COMMUNITY WATER SUPPLY.
South Okanagan Health Unit, Kelowna (British Columbia).
W. P. Moorehead, R. Guasparini, C. A. Donovan, R. G. Mathias, and R. Cottle.
Canadian Journal of Public Health CJPEA4, Vol. 81, No. 5, p 358-362, September/October 1990. 4 fig, 9 ref.

Descriptors: *Beavers, *Epidemiology, *Giardiasis, *Human diseases, *Path of pollutants, *Pathogenic bacteria, *Public health, *Water pollution sources, Canada, Population exposure, Water pollution effects.

A recent survey of trapped beaver in British Columbia indicates there is widespread infection of beaver by Giardia involving a large number of watersheds and drinking water sources. A giardiasis outbreak from a chlorinated, unfiltered surface water supply in Penticton, British Columbia (population 25,000) from June to August 1986 resulted in 362 laboratory-confirmed cases. The community utilizes chlorinated surface water from a creek and lower reservoir, and from a well. A telephone survey estimated an attack rate of over 12%. A reservoir pond containing Giardia-infected beaver was implicated as the source. No significant associations were found from a case-control study with 65 cases. A retrospective case-finding survey of records from eight (out of 35) general physicians estimated that 1,500 physician visits occurred and produced an epidemic curve in close parallel with that from laboratory-confirmed and reported cases. Despite improvements on the reservoir, another outbreak occurred when this water source was reinstituted in October for several weeks, confirming the conclusion that it was the source of the first outbreak. Various options for reducing the risk of future outbreaks are being explored including full water treatment. (Author's abstract)
W91-04362

SUBCELLULAR LOCALIZATION OF ACID-RAIN TRANSPORTED ALUMINUM IN GILLS AND KIDNEYS OF TROUT FROM STREAMS OF THE VOSGES: PRELIMINARY RESULTS, (LOCALISATION SUBCELLULAIRE DE L'ALUMINIUM VEHICULE PAR LES PLUIES ACIDES DANS LES REINS ET BRANCHIES DE TRUITE DES VOSGES. DONNEES PRELIMINAIRES).
Clermont-Ferrand-1 Univ. (France). Faculte de Medecine et de Pharmacie.
C. Galle, C. Chassard-Bouchaud, J. C. Massabuau, F. Escaig, and P. Boumati.
Comptes Rendus de l'Academie des Sciences (Serie 3) Sciences de la Vie CRAMED, Vol. 311, No. 9, p 301-307, October 25, 1990. 1 tab, 4 fig, 16 ref. (English summary).

Descriptors: *Acid rain, *Acid rain effects, *Aluminum, *Fish pathology, *Trout, *Water pollution effects, Animal tissues, France, Gills, Kidneys, Microscopic analysis, Path of pollutants.

Aluminum could be the most toxic element for fish that is produced by acid rain. Aluminum concentrations in fish gills have been studied, but the intracellular location of deposits is still not known. In this study of trout gills and kidneys, trout (Salmo trutta fario) were taken from an acidified stream in the Vosges mountains. Secondary ion emission (ion microscope) and X-ray spectrometry (electron microprobe) were used to detect intracellular localization of metals in gills and kidneys. In kidneys, aluminum was concentrated in melanosomes of melanoctyes. In gills, aluminum was detected in melanosomes, and at a higher concentration in lysosomes of macrophages. In some other trout sampled during 1987 snowmelt, aluminum in lysosomes of the kidneys' tubular cells were found, like in mammalians. However, in this study, before the sampling days, winter and spring were especially dry, the water had low acidity, and no aluminum was found in the kidneys' tubular cells, perhaps because lysosomes were excreted soon after intoxication as in mammals. (VerNooy-PTT)
W91-04364

WATERBORNE OUTBREAK OF LEPTOSPIROSIS AMONG UNITED STATES MILITARY PERSONNEL IN OKINAWA, JAPAN.
3rd Marine Division, FMFPAC, Okinawa, Japan.
A. Corwin, A. Ryan, W. Bloys, R. Thomas, and B. Deniega.
International Journal of Epidemiology IJEPBF, Vol. 19, No. 3, p 743-748, September 1990. 5 tab, 13 ref.

Descriptors: *Epidemiology, *Human diseases, *Leptospirosis, *Pathogenic bacteria, *Swimming, *Water pollution effects, *Water pollution sources, Japan, Military reservations, Okinawa, Population exposure, Public health.

A waterborne outbreak of leptospirosis occurred among US military personnel during September 1987, on the island of Okinawa, Japan. Microagglutination titers for leptospiral antigen of > or = 200 were detected in hospitalized adult males averaging 22.5 years of age with symptoms compatible with leptospirosis. Epidemiological findings revealed two case clusters distinguished by time and place of exposure. The overall attack rates among recreational swimmers and combat skills training participants were 467/1000 (7/15) and 183/1000 (15/32), respectively. Swallowing of water differentiated individuals with laboratory-confirmed infection from those with no infection, while water immersion alone did not appear to result in leptospiral infection. The seemingly high attack rates for the two recognized case clusters were most likely attributable to the unusually dry weather recorded during July and August 1987, just prior to and during exposure. Subnormal rainfall probably led to the concentration of infected animal populations around remaining sources of water and may have contributed to the risk of exposure associated with this outbreak. (Author's abstract)
W91-04365

WATER CONTACT AND SCHISTOSOMA HAEMATOBIUM INFECTION: A CASE STUDY FROM AN UPPER EGYPTIAN VILLAGE.
United States Medical Research Unit Number 3, Cairo, Egypt.
H. Kloos, G. I. Higashi, V. D. Schinski, N. S. Mansour, and K. D. Murrell.
International Journal of Epidemiology IJEPBF, Vol. 19, No. 3, p 749-758, September 1990. 2 fig, 5 tab, 37 ref. US Medical Research and Development Command, WA Unit MR0410901-0153.

Descriptors: *Egypt, *Epidemiology, *Human pathogens, *Nile River, *Public health, *Schistosomiasis, *Swimming, *Water pollution effects, Case studies, Cercariae, Multivariate analysis, Population exposure.

The quantitative relationship between water contact and Schistosoma haematobium infection was studied in a cohort of male school children aged 6 to 17 in El Ayaisha village, Upper Egypt, during a two year study. An exposure index (total body minutes, TBM) was used to identify the activities responsible for exposure to cercariae-infested water and to examine the relationship between water contact and infection. Results show that 65% of all contacts and 86% of all TBM were due to swimming in the Nile and canals and that swimming was the most important exposure and contamination activity. Using multivariate analysis, several sites, study periods, residence groups and primarily canal contacts were significantly correlated with egg-counts. Positive relationships could also be identified using egg-counts with water contact data from preceding study periods, indicating the influence of pre-existing infections, prepatency and seasonality of water contact and transmission. TBM were usually more significantly correlated with egg-counts than frequency and duration of contact. The relevance of the findings for control programs and the use of school children and the exposure index for water contact studies are discussed. Although the exposure index which incorporates a measure of intensity of water contact proved to be more appropriate than mere duration and frequency of exposure, this study indicates that water contacts should be weighted further according to season, site and possible time of day. (Author's abstract)
W91-04366

LISTERIA MONOCYTOGENES CONTAMINATION OF CROPS GROWN ON SOIL TREATED WITH SEWAGE SLUDGE CAKE.
Biological Research Center, Baghdad (Iraq).
M. R. Al-Ghazali, and S. K. Al-Azawi.
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 5, p 642-647, November 1990. 5 tab, 28 ref.

Descriptors: *Fertilization, *Human pathogens, *Listeria, *Path of pollutants, *Sludge utilization, *Soil contamination, Alfalfa, Iraq, Pathogens, Plant tissues, Population exposure, Soil amendments, Soil analysis.

Listeria monocytogenes is a widely distributed environmental contaminant, primarily believed to be transmitted to humans and animals through contaminated foods at any point in the food chain. The use of raw fertilizers contributes to contamination. L. monocytogenes was found in the sewage sludge cake which is commonly used as an agricultural fertilizer in Iraq. Soils treated with this material were contaminated with the organism. Pot and field experiments showed that crops grown on treated soil became contaminated with L. monocytogenes. When alfalfa plants were grown on farmland soil treated with sewage sludge cake, listerias were found on 10% of 50 plants sampled at harvest, but the organism was detected only in low numbers on these crops (< or = 5 cells/g). This, however, could add to the risk to animals and man. (Author's abstract)
W91-04367

ALTERATIONS IN THE MAJOR HETEROTROPHIC BACTERIAL POPULATIONS ISOLATED FROM A STILL BOTTLED MINERAL WATER.
Coimbra Univ. (Portugal). Dept. de Zoologia.
P. V. Morais, and M. S. da Costa.
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 5, p 750-757, November 1990. 4 fig, 1 tab, 22 ref.

Descriptors: *Bottled water, *Drinking water, *Heterotrophic bacteria, *Mineral water, *Pseudomonas, *Water pollution sources, Bacterial analysis, Chemical analysis, Incubation, Population dynamics.

In Europe, bottled mineral waters cannot be treated for the elimination of microorganisms by disinfection or sterilization, but it is also clearly stated that the recoverable bacterial counts should result only from a normal increase of bacteria present in the source. The heterotrophic bacterial population of a bottled mineral water stored in returnable glass bottles and in polyvinyl chloride (PVC) bottles at room temperature was studied over 9 to 12 months. The plate counts in R2A medium incubated at 22 and 37 C were low initially, increasing to 10,000 to 100,000 colony-forming units/ml within a few days of bottling. The number of bacteria recovered at 22 C from PVC bottles was fairly constant during the storage period, but the population isolated at 37 C decreased markedly after storage for 1 year. The major components of the population were Pseudomonas strains, one of which was identified as Pseudomonas vesicularis. Major changes took place during storage; two groups of bacteria (B and C) were dominant initially, but during the latter period of storage other groups (F, G and H) increased in number. These results show that long-term changes in the major heterotrophic bacterial populations of bottled mineral water occur which may reflect changes in available nutrients, a decrease in viability of some strains, competition, antagonism or other factors not yet understood. Producers should examine and characterize major bacterial populations at the source and in bottled water in addition to the routine microbiological control procedures. (Author's abstract)
W91-04368

THERMOPHILIC CAMPYLOBACTERS IN SURFACE WATERS AROUND LANCASTER, UK: NEGATIVE CORRELATION WITH CAMPYLOBACTER INFECTIONS IN THE COMMUNITY.
Lancaster Univ. (England). Div. of Biological Sciences.
K. Jones, M. Betaieb, and D. R. Telford.
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 5, p 758-764, November 1990. 7 tab, 27 ref.

Descriptors: *Campylobacter, *Human diseases, *Path of pollutants, *Pathogens, *Population exposure, *Public health, Bacterial analysis, Correlation analysis, Drinking water, Lancaster, Monitoring, Seasonal variation, Surface water data, United Kingdom, Water pollution, Water sampling.

The incidence of campylobacter enteritis in Lancaster City Health Authority is three times the UK average for similar sizes of population and has marked seasonal peaks in May and June. Environmental monitoring of surface waters around Lancaster showed that thermophilic campylobacters were absent from drinking water from the fells and from the clean upper reaches of the River Conder but were present in the main rivers entering Morecambe Bay, the lower reaches of the River Conder, the Lancaster canal, and seawater from the Lune estuary and Morecambe Bay. All the surface waters tested showed the same seasonality, namely, higher numbers in the winter months and low numbers or none in May, June and July. The absence of thermophilic campylobacters in the summer months may be due to high sunshine levels, because experiments on the effects of light showed that campylobacters in sewage effluent and seawater were eliminated within 60 and 30 min of daylight respectively, but survived for 24 hours in darkness. As the concentration of campylobacters in surface waters were at their lowest precisely at the time of peak infections in the community it is unlikely that surface waters form Lancaster's reservoir of campylobacter infection for the community. (Author's abstract)
W91-04369

TROUBLESHOOTING AN EXISTING TREATMENT PLANT.
Black and Veatch, Cincinnati, OH.
For primary bibliographic entry see Field 5F.
W91-04373

WATER DISINFECTION: A RELATIONSHIP BETWEEN OZONE AND ALDEHYDE PRODUCTION.
Turin Univ. (Italy). Dept. of Hygiene and Community Medicine.
For primary bibliographic entry see Field 5F.
W91-04378

OZONATION OF SULFUR-CONTAINING ALIPHATIC COMPOUNDS IN AQUEOUS SOLUTION: I.
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. Wassertechnologie.
For primary bibliographic entry see Field 5F.
W91-04384

QUINOXALINE OZONATION IN AQUEOUS SOLUTION.
Naples Univ. (Italy). Ist. di Ricerche sulla Combustione.
For primary bibliographic entry see Field 5F.
W91-04385

LAND CLEARANCE AND RIVER SALINISATION IN THE WESTERN MURRAY BASIN, AUSTRALIA.
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 4C.
W91-04386

SOLUTIONS OF ONE-DIMENSIONAL WATER FLOW AND MASS TRANSPORT EQUATIONS IN VARIABLY SATURATED POROUS MEDIA BY THE FINITE ELEMENT METHOD.
Thessaloniki Univ., Salonika (Greece). School of Agriculture.
V. Z. Antonopoulos, and Z. G. Papazafiriou.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 151-167, November 1990. 8 fig, 15 ref, append.

Descriptors: *Finite element method, *Groundwater movement, *Model studies, *Path of pollutants, *Porous media, *Saturated flow, *Solute transport, *Unsaturated flow, Greens theorem, Mathematical equations, Mathematical models, Peclet number, Vertical flow.

The study of simultaneous movement of water and transport of solutes under transient unsaturated-saturated conditions is important in many branches of agriculture, environmental engineering, and groundwater pollution. The Galerkin finite element method is used to solve problems of one-dimensional, vertical flow of water and mass transport of conservative solutes in variably saturated porous media. The method is applied to solve the original equation of mass transport, where Green's theorem is used to remove the second derivatives, either of the total mass flux (convection and dispersion) term or the flux due only to dispersion. The method also is applied to solve a modified mass transport equation. In all cases, linear one-dimensional elements are used. The resulting computational schemes are applied to (1) a clay loam soil, where the flow conditions lead to small Peclet numbers, ranging from 0.5 to 2.4, (2) a sandy soil, where the Peclet numbers ranged from 7.5 to 32.7, and (3) another sandy soil, where the Peclet numbers ranged from 24 to 30. The modified mass transport equation gives better results than does the original equation. Comparison of the solutions obtained by the application of the original equation shows that the results obtained by removing the second derivatives of the dispersion term are close to those obtained by the modified equation. (Author's abstract)
W91-04396

RELATIONSHIPS BETWEEN GROUNDWATER CONTAMINATION AND MAJOR-ION CHEMISTRY IN A KARST AQUIFER.
Kentucky Univ., Lexington.
B. R. Scanlon.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 271-291, November 1990. 13 fig, 2 tab, 26 ref.

Descriptors: *Groundwater pollution, *Karst, *Aquifers, *Kentucky, *Path of pollutants, *Water chemistry, Bioindicators, Fertilizers, Groundwater movement, Monitoring, Nitrates, Organic matter, Self-purification, Site selection, Waste disposal, Water classification, Water pollution sources.

Groundwater contamination was examined within a rural setting of the Inner Bluegrass Karst Region of central Kentucky, where potential contaminant sources include soil organic matter, organic and inorganic fertilizer, and septic tank effluents. Data on nitrate concentrations and indicator bacteria in water from wells and springs were compared with physical and chemical attributes of the groundwater system. Bacterial densities greater than the recommended limit were found in all springs and approximately half of the wells, whereas nitrate concentrations > 45 mg/L were restricted to 20% of the springs and 10% of the wells. Nitrate concentrations varied markedly in closely spaced wells and springs, which indicates that land use is not the primary control on groundwater contamination. Groundwater contamination is related to the distribution of chemical water types in the study area. All Ca subtype water was contaminated with nitrate and bacteria. Temporal fluctuations in nitrate concentrations of Ca subtype water are attributed to seasonal fluctuations in recharge and in plant growth. Ca-Mg subtype water generally was not contaminated and Na-HCO3 and Na-Cl water types were not contaminated. Ca-Mg subtype water, and Na-HCO3 and Na-CL water types are associated with longer residence times and reducing conditions, which allow bacterial die-off and denitrification, respectively. Differences in residence time and reducing conditions among the chemical water types and subtypes are attributed to variations in rock permeability and to occurrence of horizontal shales that control the rate and depth of active groundwater circulation. This relationship between chemical water types and contaminant concentrations is important for groundwater monitoring programs and the siting of waste-disposal facilities. (Author's abstract)
W91-04403

METEOROLOGICAL FACTORS INFLUENCING THE RADIOACTIVE DEPOSITION IN FINLAND AFTER THE CHERNOBYL ACCIDENT.
Helsinki Univ. (Finland). Dept. of Meteorology.
T. Puhakka, K. Jylha, P. Saarikivi, J. Koistinen, and J. Koivukoski.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 813-829, September 1990. 12 fig, 44 ref.

Descriptors: *Chernobyl accident, *Fallout, *Finland, *Meteorology, *Path of pollutants, *Radioactive wastes, *Rainfall distribution, Correlation analysis, Europe, Spatial distribution, Weather radar, Wet deposition.

After the accident at the Chernobyl nuclear power plant on 26 April 1986, much of Europe was affected by radioactive pollution. The first releases were transported toward Scandinavia, where most of the fallout was attributable to wet deposition. The synoptic scale and mesoscale meteorological conditions influencing the transport, and meteorological factors related to the observed transport in southern Finland were analyzed. The study focused on the role of rainfall in the final deposition onto the ground, as indicated by radar data. Although the large-scale transport from Chernobyl could be estimated roughly by simple methods using routine synoptic data, some essential smaller-scale features could not be understood before an isentropic trajectory analysis, together with a conceptual model of a cyclone and its related conveyer belts, was applied. The main result of the study was the good correlation between the radioactive fallout and the corresponding areal distribution of rainfall measured by weather radar. (Author's abstract)
W91-04430

RESULTS OF A TEN-YEAR STUDY (1976-1986) OF THE POPULATIONS IN SOFT SUBSTRATES OFF A WASTEWATER OUTFALL: MARSEILLE-CORTIOU. (LES ENSEIGNEMENTS D'UNE ETUDE SUR DIX ANS (1976-1986) DES PEUPLEMENTS DE SUBSTRATS MEUBLES AU LARGE D'UN EMISSAIRE D'EAUX USEES: MARSEILLE-CORTIOU).
Centre d'Oceanologie de Marseille (France).
For primary bibliographic entry see Field 5C.
W91-04440

CHANGES IN FISH MERCURY CONCENTRATIONS IN AN INTENSIVELY FISHED LAKE.
Water and Environment Research Inst., Helsinki (Finland).
M. Verta.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 1888-1897, October 1990. 6 fig, 4 tab, 34 ref.

Descriptors: *Bioaccumulation, *Heavy metals, *Lake restoration, *Mercury, *Path of pollutants, *Water pollution, Biomass, Fish metabolism, Fishing, Food chains, Lake fisheries.

A small polyhumic lake inhabited by northern pike (Esox lucius), burbot (Lota lota), perch (Perca fluviatilis), roach (Rutilus rutilus), and eel (Anguilla anguilla) was fished intensively during spring 1984 and 1985 to lower the high mercury levels in the top predator, northern pike. A total catch of 29.5 kg/ha (74% roach) was removed which represented about 50% of the total fish biomass. Mercury concentrations in burbot, large pike, and small roach had decreased by 1987 and 1988, but increased in young pike and some perch. Northern pike had the clearest increase in growth rate, while that of perch and roach levelled off within 3 years at the prefishing level. Only a small increase in growth rate of burbot occurred. The yearly accumulation of mercury in northern pike remained constant, and the decrease in mercury accumulation was apparently due to growth dilution. The decrease in mercury accumulation of burbot and roach is explained by a switch to a diet with lower mercury levels or a decrease in water methylmercury concentrations. The amount of methylmercury removed from the lake by fishing was equivalent to several years of calculated mercury methylation and accumulation in the fish. Overfishing may be a feasible means of lowering methylmercury levels in this type of oligotrophic lake. (Author's abstract)
W91-04441

INFLUENCE OF WATER CHEMISTRY ON SIZE STRUCTURE OF ZOOPLANKTON ASSEMBLAGES.
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
For primary bibliographic entry see Field 2H.
W91-04442

FOOD CHAIN STRUCTURE IN ONTARIO LAKES DETERMINES PCB LEVELS IN LAKE TROUT (SALVELINUS NAMAYCUSH) AND OTHER PELAGIC FISH.
McGill Univ., Montreal (Quebec). Dept. of Biology.
J. B. Rasmussen, D. J. Rowan, D. R. S. Lean, and J. H. Carey.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 10, p 2030-2038, October 1990. 1 fig, 3 tab, 67 ref.

Descriptors: *Bioaccumulation, *Food chains, *Ontario, *Path of pollutants, *Polychlorinated biphenyls, *Trout, Air pollution, Atmospheric circulation, Dispersal, Fish physiology, Trophic level.

The trophic structure of pelagic communities in lakes of glaciated regions is highly variable due to restricted dispersal of glacial relict taxa and recent species introductions. Much of the enormous between-lake variability in PCB levels in lake trout flesh (15 to 10,000 ng/g) from the St. Lawrence system results from differences in the length of pelagic food chains. Ontario Ministry of the Environment data (1987 to 1981) on PCB concentrations in lake trout flesh indicate that PCB concentrations increased with the length of the food chain and tissue lipid content, and decreased with distance north of urban-industrial centers. Each trophic level contributed about a 3.5-fold biomagnification factor to the PCB concentrations in the trout, and the lipid content of the trout flesh increased by a factor of 1.5 for each additional trophic level. An empirical model capable of predicting PCB levels in pelagic salmonids and forage fish (smelt and coregonids) indicated that biomagnification of small atmospheric inputs of persistent lipophilic contaminants can explain the frequent occurrence of high levels of contaminants in some biota from remote areas, and that species introductions that lengthen food chains will lead to significant increases in levels of atmospherically dispersed persistent organic contaminants in top predators. (Author's abstract)
W91-04445

HEALTH EFFECTS OF BEACH WATER POLLUTION IN HONG KONG.
Hong Kong Environmental Protection Dept.
For primary bibliographic entry see Field 5C.
W91-04454

INCIDENCE OF VIRULENCE FACTORS IN MESOPHILIC AEROMONAS SPECIES ISOLATED FROM FARM ANIMALS AND THEIR ENVIRONMENT.
University Hospital of Wales, Cardiff. Public Health Lab.
S. J. Gray, D. J. Stickler, and T. N. Bryant.
Epidemiology and Infection EPINEU, Vol. 105, No. 2, p 277-294, October 1990. 4 tab, 52 ref.

Descriptors: *Aeromonas, *Bacterial toxins, *Farm wastes, *Fecal coliforms, *Feces, *Human pathogens, *Virulence, *Water pollution sources, Cytotoxicity, Microbiological analysis, Statistical analysis.

Sixty-one isolates of Aeromonas spp. from the feces of pigs, cows and a variety of associated environmental sources were examined for the characteristics that are reputed to have roles in pathogenicity. Most isolates of Aeromonas hydrophila were cytotoxic (96.4%) and were capable of producing cell elongation factor (75%) and hemagglutinins (67.9%). In contrast, few of the Aeromonas caviae isolates produced these three markers (13.6%, 27.3% and 36.4% respectively). In general, Aeromonas sobria occupied an intermediate position (36.4%, 27.3% and 54.5%), but they did produce the highest mean invasion index for HEp-2 cells. Statistical analysis revealed significant associations between these factors. Many isolates of aeromonads from water and animals possessed the full battery of putative virulence factors. (Author's abstract)
W91-04455

FAECAL CONTAMINATION OF WATER AND FINGERTIP-RINSES AS A METHOD FOR EVALUATING THE EFFECT OF LOW-COST WATER SUPPLY AND SANITATION ACTIVITIES ON FAECO-ORAL DISEASE TRANSMISSION. I. A CASE STUDY IN RURAL NORTH-EAST THAILAND.
Leeds Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-04456

FAECAL CONTAMINATION OF WATER AND FINGERTIP-RINSES AS A METHOD FOR EVALUATING THE EFFECT OF LOW-COST WATER SUPPLY AND SANITATION ACTIVITIES ON FAECO-ORAL DISEASE TRANSMISSION. II. A HYGIENE INTERVENTION STUDY IN RURAL NORTH-EAST THAILAND.
Leeds Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-04457

GC/MS BASED ANALYSES OF INDIVIDUAL ORGANIC CONSTITUENTS OF CHAO PHRAYA RIVER WATER AND ESTIMATED DISCHARGE RATES INTO THE UPPER GULF OF THAILAND.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
M. Ehrhardt, G. Wattayakorn, and R. Dawson.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 5, p 439-451, May 1990. 9 fig, 6 tab, 8 ref.

Descriptors: *Organic pollutants, *Path of pollutants, *Pollutant identification, *Stream pollution, *Thailand, *Water pollution sources, Chao Phraya River, Gas chromatography, Hydrocarbons, Mass spectroscopy, Organic matter.

Detailed gas chromatography/mass spectroscopy based chemical analyses of organic concentrates from the Chao Phraya River obtained from a water sample collected in the Bangkok metropolitan area indicated that hydrocarbons of petroleum or combustion sources may be minor constituents of the dissolved lipophilic fraction relative to biogenic hydrocarbons and industrial chemicals. Using data on river discharge and the concentrations measured in an integrated sample, tentative input rates into the Upper Gulf of Thailand for characterized chemicals are calculated. A suite of isometric phenoxytetradecanes of almost certain anthropogenic origin, whose combined concentrations far exceed those of any other characterized lipophilic material was detected. Further investigations on their environmental effects may be expedient before embarking on costly ventures to monitor the more common constituents such as petroleum residues or halogenated hydrocarbons, an approach which may altogether miss contaminants of equal or greater importance. (Author's abstract)
W91-04458

HYDROGEOLOGY AND GROUND-WATER-QUALITY CONDITIONS AT THE EMPORIA-LYON COUNTY LANDFILL, EASTERN KANSAS, 1988.
Geological Survey, Lawrence, KS. Water Resources Div.
N. C. Myers, and P. R. Bigsby.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4043, 1990. 42p, 13 fig, 11 tab, 28 ref. Project No. KS138.

Descriptors: *Geohydrology, *Groundwater, *Groundwater movement, *Groundwater pollution, *Landfills, *Path of pollutants, *Water pollution sources, Contamination, Emporia, Kansas, Pollutants, Water quality.

Hydrogeology and water-quality conditions at the Emporia-Lyon County Landfill, eastern Kansas, were investigated from April 1988 through April 1989. Potentiometric-surface maps indicated groundwater movement from the northeast and northwest towards the landfill and then south through the landfill to the Cottonwood River. The maps indicate that during periods of low groundwater levels, groundwater flows northward in the north-west part of the landfill, which may have been induced by water withdrawal from wells north of the landfill or by water ponded in waste lagoons south and west of the landfill. Chemical analysis of water samples from monitoring wells upgradient and downgradient of the landfill indicate calcium bicarbonate to be the dominant water type. No inorganic or organic chemical concentrations exceeded Kansas or Federal primary drinking-water standards. Kansas secondary drinking-water standards were equaled or exceeded, however, in water from some or all wells for total hardness, dissolved solids, iron, and manganese. Water from one upgradient well contained larger concentrations of dissolved oxygen and nitrate, and smaller concentrations of bicarbonate, alkalinity, ammonia, arsenic, iron, and manganese as compared to all other monitoring wells. Results of this investigation indicate that groundwater quality downgradient of well MW-2 has increased concentrations of some inorganic and organic compounds. Due to the industrial nature of the area and the changing directions of groundwater flow, it is not clear what the source of these compounds might be. Long-term monitoring, additional wells, and access to nearby waste lagoons and waste-lagoon monitoring wells would help define the sources of increased inorganic and organic compounds. (USGS)
W91-04468

HYDROGEOCHEMICAL DATA FROM AN ACIDIC DEPOSITION STUDY AT MCDONALDS BRANCH BASIN IN THE NEW JERSEY PINELANDS, 1983-86.
Geological Survey, Trenton, NJ. Water Resources Div.
D. G. Lord, J. L. Barringer, P. A. Johnsson, P. F. Schuster, and R. L. Walker.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-500, 1990. 132p, 18 fig, 24 tab, 64 ref.

Descriptors: *Acid rain, *New Jersey, *Water quality, Groundwater quality, Water chemistry, Water pollution sources.

Data from a 1983-86 acidic-deposition study at McDonalds Branch basin, a small (2.35-sq-mi) forested watershed in Lebanon State Forest, New Jersey include mineralogy of soil and depositional clays; physical and chemical analyses of soils; hydrologic measurements (precipitation and throughfall amounts, stream stage and discharge, and water-table altitudes); and water quality data from precipitation, throughfall, soil water, surface water, and groundwater. Site locations, collector designs, and well-construction data also are presented. The pH of bulk precipitation to McDonalds Branch basin over the sampling period (January 1985 to March 1986) ranged from 4.0 to 4.7, with a mean of approximately 4.3. Stream pH ranged from 3.2 to 4.8 and generally increased in a downstream direction. In general sulfate was the dominant anion throughout the basin. Aluminum concentrations commonly were elevated in surface and groundwaters, and were as high as 10,000 micrograms/L at one upstream site on McDonalds Branch. Dissolved organic carbon was an important component of stream waters in some locations and ranged in concentration from 1/1 to 37 mg/L. (USGS)
W91-04472

GROUND-WATER-QUALITY ASSESSMENT OF THE CARSON RIVER BASIN, NEVADA AND CALIFORNIA: ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2K.
W91-04476

PURGEABLE ORGANIC COMPOUNDS IN GROUND WATER AT THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO--1988 AND 1989.
Geological Survey, Idaho Falls, ID. Water Resources Div.
L. J. Mann.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-367, 1990. 17p, 2 fig, 2 tab, 13 ref. Contract No. DE-AI07-81ID12306. Project No. ID-165.

Descriptors: *Data collections, *Groundwater pollution, *Organic compounds, *Water pollution sources, *Water quality, Chemical analysis, Groundwater, Quality control.

Groundwater samples from 38 wells at the Idaho National Engineering Laboratory were analyzed for 36 purgeable organic compounds in 1988-89. Thirty-six of the wells obtain water from the Snake River Plain aquifer and were equipped with dedicated or portable pumps. Water samples from one well that obtains water from the aquifer and one that obtains water from a perched groundwater zone were collected using a thief sampler. Analyses of water from 22 wells indicated the aquifer locally contained detectable concentrations of at least 1 of 19 purgeable organic compounds, mainly carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene. Except for five wells, the maximum concentration of a specific compound in groundwater was 6.4 microgram/L or less; concentrations of most compounds were less than 0.2 microgram/L. Water from four wells at and near the Test Area North contained from 44 to 29,000 micrograms/L of trichloroethylene. Water from a well that obtains water from a discontinuous perched groundwater zone at the Radioactive Waste Management Complex contained 1,400 micrograms/L of carbon tetrachloride, 940 micrograms/L of chloroform, 250 micrograms/L of 1,1,1-trichloroethane, and 1,100 micrograms/L trichloroethylene. Selected purgeable organic compounds, such as total xylene and methylene chloride, were detected in some groundwater samples and some blank samples consisting of boiled deionized water. Their presence in the blank samples suggest the compounds could have been inadvertently introduced into the groundwater sampled during or subsequent to collection. (USGS)
W91-04478

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: I. SOIL AND LEACHATE WATER QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W91-04509

IRRIGATION OF TURFGRASS WITH SECONDARY SEWAGE EFFLUENT: II. TURF QUALITY.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W91-04510

DAILY U INTAKE IN UTAH RESIDENTS FROM FOOD AND DRINKING WATER.
Utah Univ., Salt Lake City. School of Medicine.
N. P. Singh, D. P. Burleigh, H. M. Ruth, and M. E. Wrenn.
Health Physics HLTPAO, Vol. 59, No. 3, p 333-337, September 1990. 4 fig, 1 tab, 14 ref. EPA Grant CR8-12681-01.

Descriptors: *Drinking water, *Human physiology, *Path of pollutants, *Uranium, *Uranium radioisotopes, *Utah, *Water pollution, Dietary intake, Feces, Urine.

Uranium is accumulated in the human body by the ingestion of food and drinking water and the inhalation of dust particles. Uranium measurements in urine and feces were investigated in twelve human subjects in Utah. All twelve subjects were normal in kidney function and free of any indication of complicating pathology. The concentration of uranium isotopes in urine, feces, and drinking water were determined using a solid state alpha spectrometer. Results suggest that the daily uranium intake in the Utah population is higher than that of New York City, Chicago, and San Francisco residents. The uranium concentration in Salt Lake City drinking water is higher than the uranium concentration in New York City tap water, and the total dietary intake of uranium in the Salt Lake City, which is half the Utah population, is higher than that of New York City, Chicago, and San Francisco residents. No relationship existed between the subjects' age and the daily uranium excretion, between the fecal wet weight and the daily uranium excretion, and the daily uranium intake varied from person to person and day to day for each individual. A better way to estimate the daily uranium intake in man is to determine the total daily urinary and fecal excretions of uranium, rather than estimating from the uranium concentrations in various food items. (Brunone-PTT)
W91-04511

INTENSE AND LOCALIZED BENTHIC MARINE POLLUTION AROUND MCMURDO STATION, ANTARCTICA.
Moss Landing Marine Labs., CA.
H. S. Lenihan, J. S. Oliver, J. M. Oakden, and M. D. Stephenson.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 9, p 422-430, September 1990. 4 fig, 3 tab, 32 ref. NSF Grant NSF-DPP 8716460.

Descriptors: *Antarctica, *Benthic fauna, *Hydrocarbons, *Marine animals, *Marine pollution, *McMurdo Station, *Path of pollutants, *Polar regions, *Water pollution sources, Ecosystems, Heavy metals, Marine sediments, Polychaetes, Sediment chemistry, Species diversity, Trace metals, Winter Quarters Bay.

Benthic sediments and animals are highly modified by human activities at McMurdo Station, the largest human settlement in Antarctica. The quantity of anthropogenic debris, contamination of marine sediments with hydrocarbons and metals, and gross changes in benthic communities are largely confined to Winter Quarters Bay, adjacent to the former dump site and the ice dock used by visiting ships. Levels of purgeable hydrocarbons in bay sediments are as high as 4500 ppm. Metals levels are mostly high within the bay, but are not greater than in the most polluted temperate habitats. Levels of anthropogenic chemicals are significantly higher in the back bay compared to stations established at different distances from the bay (along three potential contamination gradients), including reference sites many kilometers away. Significant negative correlations exist between the total number of infauna or epifauna and the concentrations of hydrocarbons and most metals in sediments. The few animals living in the back bay are motile polychaete worms with opportunistic life histories. The local physical setting apparently permits little transport of contaminated sediments from the bay, which is flanked on one side by a large submarine ridge and on the other from Hut Point. Hut Point also protects the bay from oceanic conditions. The back bay is over 30 m deep and the ridge top is only 18 m deep. The gradient of chemical and community change is extremely steep, but observable ecological impacts exist outside the bay along the front of the station. Although most historical inputs of pollution are removed or reduced and continued cleanup is planned, Winter Quarters Bay may require many decades to recover. (Author's abstract)
W91-04514

INFLUENCE OF PIG FARMING ON THE COPPER CONTENT OF ESTUARINE SEDIMENTS IN BRITTANY, FRANCE.
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest. Dept. Environnement Littoral.
G. Arzul, and J.-F. Maguer.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No.

9, p 431-434, September 1990. 5 fig, 1 tab, 16 ref.

Descriptors: *Agricultural runoff, *Copper, *Estuarine sediments, *Farm wastes, *France, *Hogs, *Path of pollutants, *Sediment concentration, *Water pollution sources, Rainwater, Trace metals.

Feed given to pigs contains trace minerals, including copper at a concentration of about 125 mg/kg of whole feed, representing a mean addition, via slurry application, of about 0.6 kg copper/ha/yr. This copper is lost from the soil mainly by rainwater washout, passing via streams to nearby estuaries. Total copper content in sediment from different estuaries has been measured along Brittany coast (France). A direct relationship exists between grain size and copper concentration, with higher concentrations in the fine grain fraction. The relationship between copper content and organic matter approximates a linear relationship. The best correlation was a semilogarithmic relationship between total copper concentration and pigs (excluding suckling pigs) per ha cultivated in the same canton. The copper content in estuarine sediments is an indicator of the intensity of pig farming within about 10 km. With increases in both copper and organic matter, copper levels would have to reach more than 200 microg copper/g (four times the highest level in this survey) before they were comparable with those levels found in harbor and industrial areas, and more than 1000 microg copper/g to rank with levels in mining regions. (Brunone-PTT)
W91-04515

COMPARISON OF ORGANOCHLORINE RESIDUE LEVELS IN THE STRIPED DOLPHIN FROM WESTERN NORTH PACIFIC, 1978-79 AND 1986.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
B. G. Loganathan, S. Tanabe, H. Tanaka, S. Watanabe, and N. Miyazaki.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 9, p 435-439, September 1990. 1 fig, 2 tab, 44 ref. Ministry of Education, Science and Culture of Japan Grant-in-Aid Project No. 63041094.

Descriptors: *Bioaccumulation, *Cetaceans, *Marine animals, *Marine pollution, *Organochlorines, *Pacific Ocean, *Path of pollutants, *Porpoises, *Water pollution, Animal metabolism, Contamination, DDT, Japan, Mammals, Polychlorinated biphenyls.

Blubber samples of adult male striped dolphins (Stenella coeruleoalba) from the Pacific coast of Japan collected during 1978-1979 and 1986 were analyzed for persistent organochlorines such as PCB isomers and congeners, DDT compounds, HCH (BHC) isomers and HCB to investigate long-term changes in the residue levels of these contaminants. Comparison of the organochlorine levels using dolphins of the same age revealed that the level of contamination remains unchanged for PCBs and DDTs during the above period, while HCHs and HCB showed significant decreases. Unlike terrestrial animals contaminated by point source pollution, the striped dolphin is living in areas far from the contamination source. Present data indicate that persistent organochlorine contamination is still continuing in the remote marine environment. (Author's abstract)
W91-04516

COMPARISON OF TRACE METALS DATA IN MUSSELS AND OYSTERS FROM A MUSSEL WATCH PROGRAMME OF THE 1970S WITH THOSE FROM A 1980S PROGRAMME.
National Ocean Service, Rockville, MD.
G. G. Lauenstein, A. Robertson, and T. P. O'Connor.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 9, p 440-477, September 1990. 2 fig, 5 tab, 12 ref.

Descriptors: *Bioindicators, *Marine pollution, *Mollusks, *Path of pollutants, *Trace metals, Cadmium, Comparison studies, Copper, Lead, Mussels, Nickel, Oysters, Silver, Statistical analysis, Zinc.

Two Mussel Watch programs have collected and analyzed cadmium, copper, lead, nickel, silver, and zinc concentrations in bivalve molluscs around the coasts of the United States annually from two periods of three years, one in the late 1970s, the other in the late 1980s. Fifty sites were common to both programs. The two 3-year data sets have been compared by the use of two nonparametric techniques to identify changes over the ten year separating the programs. By the sign test, mean concentrations of lead were shown to have decreased on a national scale. When the results for each metal were compared station-by-station using the Mann-Whitney U-test, substantially more sites were found with decreases in cadmium and lead than with increases. For copper the converse held, substantially more sites with increases being noted. On a national scale, silver, nickel and zinc showed little evidence of change between the two data sets. (Author's abstract)
W91-04517

PETROLEUM AROMATIC HYDROCARBONS IN SURFACE WATERS AROUND ELEPHANT ISLAND, ANTARCTIC PENINSULA.
Sao Paulo Univ. (Brazil). Inst. Oceanografico.
R. R. Weber, and M. C. Bicego.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 9, p 448-449, September 1990. 1 fig, 1 tab, 6 ref.

Descriptors: *Antarctica, *Baseline studies, *Hydrocarbons, *Marine environment, *Polycyclic aromatic hydrocarbons, Elephant Island, Polar regions, Spectral analysis, Water pollution.

In order to make an accurate baseline assessment of hydrocarbons in Antarctic water before drilling for oil on the continental shelf, a survey was performed on aromatic hydrocarbons in the surface waters around Elephant Island, on the Antarctic Peninsula, during the Fifth Brazilian Antarctic Cruise of R. V. Prof. W. Besnard in the summer of 1987. The level of dissolved or dispersed aromatic hydrocarbons in 2 L water samples from 1 m depth were measured by spectrofluorometry. The waters around Elephant Island are typical of a very clean marine environment. All samples present levels of polycyclic aromatic hydrocarbons below 1 microg/L, indicating no petroleum pollution. (Brunone-PTT)
W91-04518

DISSOLVED ARSENIC IN THE ST. LAWRENCE ESTUARY AND THE SAGUENAY FJORD, CANADA.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
G. H. Tremblay, and C. Gobeil.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 465-469, 1990. 5 fig, 38 ref.

Descriptors: *Arsenic, *Estuaries, *Geochemistry, *Path of pollutants, *Saguenay Fjord, *St Lawrence Estuary, *Trace metals, Catchment areas, Fjords, River systems, Spatial distribution, Topography.

Over the salinity range of 0 to 31 ppt, total dissolved arsenic increased from 6.6 nM to 18.9 nM in the St. Lawrence Estuary and from 1.1 nM to 18.7 nM in its tributary, Saguenay Fjord. Arsenic concentrations in the riverine end-members were similar to the lowest values found in other world rivers and reflect the geology of the respective drainage basins. In the two study areas, arsenic was nearly conservative during estuarine mixing. A close examination of the spatial distribution of arsenic in the interior basin of the Saguenay Fjord suggests, however, an enrichment of arsenic in the bottom waters by a flux from the sediments. These results show that the St. Lawrence and the Saguenay do not display the effects of air-borne or water-borne contamination observed in some industrialized rivers and estuaries. (Author's abstract)
W91-04519

POLYCYCLIC AROMATIC HYDROCARBONS IN MUSCLE TISSUE OF MARINE MAMMALS FROM THE NORTHWEST ATLANTIC.
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
J. Hellou, G. Stenson, I. H. Ni, and J. F. Payne.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 469-473, 1990. 1 fig, 2 tab, 31 ref.

Descriptors: *Atlantic Ocean, *Marine mammals, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Seals, *Whales, Animal metabolism, Baseline studies, Canada, Chrysene, Hydrocarbons, Water pollution.

Because virtually no available data exist on polycyclic aromatic hydrocarbons (PAH) in marine mammals a baseline study was conducted off the eastern coast of Canada, an area stated for petroleum development. Total PAH concentrations were determined in terms of chrysene and petroleum hydrocarbon equivalents in muscle tissues of four species of seals and six species of whales from waters around Newfoundland and Labrador. Values expressed on a dry weight basis ranged from 0.10 to 1.21 ppm for chrysene equivalents and 0.26 to 5.51 ppm for petroleum equivalents. The relatively high levels found in some animals from fishing areas demonstrate a need for more comprehensive information on PAH in marine mammals. (Author's abstract)
W91-04520

MERSEY OIL SPILL, AUGUST, 1989: A CASE OF SEDIMENTS CONTAMINATING THE OIL.
Liverpool Univ. (England). Oceanography Lab.
N. J. Davies, and G. A. Wolff.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 481-484, 1990. 4 fig, 7 ref.

Descriptors: *Contamination, *England, *Hydrocarbons, *Mersey Estuary, *Oil spills, *Path of pollutants, *Sediment contamination, *Water pollution sources, Baseline studies, Chemical degradation, Estuaries.

On August 19, 1989, 150 tons of crude oil were accidentally spilled into the Mersey Estuary, UK from the Shell refinery at Stanlow, Ellesmere Port. Large areas of the estuary were oiled. Oil and sediment core samples were collected from several sites on August 20. Results from core samples in the Upper Estuary (Widnes) indicate that the effect of the spilled oil on the levels of hydrocarbons in the sediments is minimal, due to the exceptionally high background hydrocarbon contaminant levels present. Such high levels make time-course studies of the degradation of residual contaminants from the spilled oil by conventional fingerprinting methods difficult. (Author's abstract)
W91-04523

CU AND CD ASSOCIATED WITH SUSPENDED PARTICULATE MATTER IN TORRES STRAIT.
Sydney Univ. (Australia). Ocean Sciences Inst.
E. K. Baker, P. T. Harris, and R. W. Beck.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 484-486, 1990. 1 fig, 1 tab, 5 ref.

Descriptors: *Cadmium, *Contamination, *Copper, *Heavy metals, *Mine wastes, *Papua New Guinea, *Suspended solids, *Torres Strait, *Trace metals, *Water pollution sources, Catchment areas, Flow rates, Fly River Delta, River systems, Suspended sediments.

Torres Strait is the shallow expanse of water between the Cape York Peninsula and Papua New Guinea. The Fly River system of Papua New Guinea has an average annual discharge of 6000 cu m/sec and is a direct fluvial source to the northern part of Torres Strait. The purpose of this study was to determine heavy metal levels associated with the suspended particulate matter in the waters adjacent to the Fly River mouths and northeastern section of Torres Strait and to ascertain whether any metal pollution has occurred as a result of the mining activities. Suspended sediment samples were collected from surface water at 23 locations during March 1989 and analyzed by carbon furnace atomic absorption. The results indicate that the highest levels of cadmium and copper were found at the station closest to the Fly River. Cadmium concentrations exceeding 0.1 ppb were found at seven of the 23 stations. Such levels must

be considered abnormally high, as this is a measure of the concentration only in the particulate form. The suspended particulate matter in Torres Strait water is contaminated with copper and cadmium. The highest values (13.3 ppb and 0.8 ppb for copper and cadmium, respectively) were much greater that those expected background values. Since both of these values were recorded nearest the Fly River delta, this catchment is probably the source for these metals from mining operations. (Brunone-PTT)
W91-04524

TRACE METAL CONCENTRATIONS IN MANGROVE OYSTER (CRASSOSTREA CORTEZIENSIS) FROM TROPICAL LAGOON ENVIRONMENTS, MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
J. I. Osuna Lopez, H. M. Zazueta-Padilla, A. Rodriguez-Higuera, and F. Paez-Osuna.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 486-488, 1990. 2 fig, 2 tab, 9 ref.

Descriptors: *Animal metabolism, *Bioaccumulation, *Lagoons, *Mexico, *Mollusks, *Path of pollutants, *Pollutant identification, *Seasonal variation, *Trace metals, Cadmium, Chromium, Cobalt, Contamination, Copper, Heavy metals, Iron, Manganese, Mangrove trees, Nickel, Silver, Zinc.

A population of Crassostrea corteziensis was collected at four seasonal intervals between October 1987 and July 1988, in the Mazatlan harbor, a small coastal lagoon barred by an inner shelf. Total flesh metal concentrations in organisms sampled from three defined sections of the mangrove roots (sediment surface to 20 cm, 20-40 cm, and 40-60 cm) at the selected sites were determined. Oysters were measured and removed from their shells. Samples were analyzed by flame spectroscopy. The highest concentrations of metals were found in oyster samples of 44.3 +/-3.0 mm (range of 41.2-49.2 mm) rather than in 34.5 +/-2.6 mm (range of 30.7-39.0 mm) length. Maximum concentrations of copper, cobalt, nickel, manganese and zinc were recorded in autumn or winter, while chromium, silver, iron and cadmium do not appear to exhibit systematic seasonal variations. With respect to variations in metal concentrations associated with the three intervals sampled for copper, nickel, lead, cadmium and silver, highest concentrations occur in oyster that inhabit the upper sections (40-60 cm). Only copper and cobalt exhibit significantly different concentrations for the depth intervals at the 95% confidence level. With the exception of zinc, the levels in this study were low or comparable to oysters from Hansan-Koje Bay, Korea; gulf of Thailand, or from the northwest coast of Mexico (all locations with moderate or low trace metal contamination). Zinc levels are similar to the levels found in C. echinata from Darwin, Australia, a moderately polluted harbor. (Brunone-PTT)
W91-04525

SEX- AND MATURITY-RELATED HEAVY METAL ACCUMULATIONS IN THE ANTARCTIC KRILL EUPHAUSIA SUPERBA.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
Y. Yamamoto, K. Honda, Y. Endo, and R. Tatsukawa.
Proceedings of the NIPR Symposium on Polar Biology, No. 3, p 57-63, March 1990. 2 fig, 3 tab, 24 ref. Ministry of Education, Science and Culture, Japan. Project No. 63790368.

Descriptors: *Bioaccumulation, *Bioindicators, *Crustaceans, *Heavy metals, *Krill, *Path of pollutants, Animal physiology, Antarctic, Copper, Juvenile growth stage, Polar regions, Proteins, Scotia Sea, Zooplankton.

Concentrations of heavy metals and their chemical forms were sampled in the Antarctic krill (Euphausia superba) collected from the Scotia Sea in December, 1987 and the results were analyzed in relation to sex and maturity stages. The whole body metal concentrations were in the order of zinc approximately = copper > iron > manganese > nickel > cadmium. The values of iron, manganese, and zinc were higher in females than in males. The values of copper, iron, nickel, and cadmium in adult females were highest in stage IIIA. The values for copper were higher in juveniles than in adults. Concentrations of the metals were generally higher in the cephalothorax than in the abdomen. A majority of the copper in the cephalothorax was found as copper binding proteins, which were usually hemocyanin and metallothionein. Changes in amounts of copper binding proteins by physiological conditions might be important in the variability of copper concentrations between sexes and between maturity stages of the Antarctic krill. (Author's abstract)
W91-04530

INTENSIVE POTATO PRODUCTION EFFECTS ON NITRATE-N CONCENTRATIONS OF RURAL NEW BRUNSWICK WELL WATER.
Agriculture Canada, Fredericton (New Brunswick). Research Station.
J. E. Richards, P. H. Milburn, A. A. Maclean, and G. P. Demerchant.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 189-196, July 1990. 5 fig, 3 tab, 36 ref.

Descriptors: *Canada, *Crop production, *Fertilizers, *Groundwater pollution, *New Brunswick, *Nitrates, *Nonpoint pollution sources, *Potatoes, *Rural areas, *Water pollution sources, Agricultural hydrology, Coliforms, Farms, Land use, Nutrient transport, Well water.

There is considerable current worldwide concern about the effects of intensive agricultural production on groundwater quality. A study was conducted to determine if the intensity of agricultural land use, in particular potato production, was related to nitrate-N (NO3-N) concentrations in private rural groundwater wells in New Brunswick, Canada, and to determine if the concentration of NO3-N changed over 15 years in these wells. Samples of 47 wells were taken from 1973 to 1976 and in 1988 from farms in three agricultural regions in northwestern New Brunswick. Wells in a rural nonagricultural region near Fredericton were sampled in 1988. The most intensely-cropped region (St. Andre) had 20-25% of its land area cropped to potatoes; the other two agricultural regions had substantially less area cropped to potatoes (7-9%). Mean NO3-N concentrations were least in the Fredericton region (1.1 mg/L) and greatest in the St. Andre region (9.5 mg/L). Elevated NO3-N concentrations were due to nonpoint effects; average NO3-N concentrations of the three agricultural study regions were unaltered when waters containing more than 10 coliform bacteria per 100 ml were removed from analysis, suggesting that NO3-N in well waters was derived from soil-N or fertilizer-N. The mean concentration of NO3-N in wells of the study agricultural regions was associated with the proportion of the land base cropped to potatoes. In one of the agricultural study regions, the mean concentration of NO3-N decreased over the course of the study while there was no significant change in NO3-N concentrations in the other two agricultural study regions. (Author's abstract)
W91-04546

GLOBAL METAL POLLUTION: POISONING THE BIOSPHERE.
National Water Research Inst., Burlington (Ontario).
J. O. Nriagu.
Environment ENVTAR, Vol. 32, No. 7, p 7-11,28-33, September 1990. 1 fig, 6 tab, 43 ref.

Descriptors: *Air pollution sources, *Environmental impact, *Human population, *Industrial development, *Industrial wastes, *Metals, *Path of pollutants, *Trace metals, *Water pollution sources, Antimony, Arsenic, Atmosphere, Cadmium, Copper, Developing countries, Economic growth, Fate of pollutants, Lead, Mercury, Nickel, Public health, Soil contamination, Urban areas, Vanadium, Zinc.

Marked increases in global population and in the gross national products of developed countries since the beginning of this century have been accompanied by a rapid increase in metal production. Each new process or compound used in scientific research and development can generate a different type of metallic waste, and such waste is usually discharged into the environment, where it can disrupt natural processes and endanger human health. Industrial emissions have become dominantly responsible for most of the trace elements in the air. Anthropogenic emissions of lead, cadmium, vanadium, and zinc exceed the fluxes from natural sources by 28-, 6-, 3-, and 3-fold, respectively. Industrial contributions of arsenic, copper, mercury, nickel, and antimony amount to 100 to 200% of emissions from natural sources. The metals released from industrial sources are rapidly dispersed into different environmental compartments; urban environments are 'hot spots' of toxic metals, exceeding airborne trace metal levels of rural areas by 5 to 10-fold and levels in remote locations by more than 100-fold for many elements. The highest concentrations of lead in the marine atmosphere are found near the urban-industrial areas of Western Europe and eastern North America, and the lowest levels are found in Antarctica. Soils represent the ultimate sink for trace metals in continental areas. Environmental metal pollution may either result in direct assaults on human health or have indirect effects on human welfare by interfering with the integrity and vitality of the life-support systems. Economic pressures are likely to stimulate increased metal loadings into the environmental compartments of developing countries. (Fish-PTT)
W91-04558

DESIGN AND PERFORMANCE OF AN ACIDIC PRECIPITATION DELIVERY SYSTEM FOR FIELD INVESTIGATION WITH PLANTS.
Boyce Thompson Inst. for Plant Research, Ithaca, NY.
For primary bibliographic entry see Field 5C.
W91-04568

EXPOSURE ASSESSMENT OF SEWAGE TREATMENT PLANT EFFLUENT BY A SELECTED CHEMICAL MARKER METHOD.
Clement Associates, Inc., Fairfax, VA.
For primary bibliographic entry see Field 5D.
W91-04570

EFFECTS OF CADMIUM IN FRESHWATER CLAMS. I. INTERACTION WITH ESSENTIAL ELEMENTS IN ANODONTA CYGNEA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
For primary bibliographic entry see Field 5C.
W91-04572

METAL CONCENTRATIONS IN PELAGIC SEABIRDS FROM THE NORTH PACIFIC OCEAN.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
K. Honda, J. E. Marcovecchio, S. Kan, R. Tatsukawa, and H. Ogi.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 704-711, September/October, 1990. 1 fig, 3 tab, 36 ref. Toyota Foundation Grant 85-I-134-359, 87-III-020.

Descriptors: *Bioaccumulation, *Heavy metals, *Pacific Ocean, *Path of pollutants, *Water birds, Cadmium, Copper, Geographical variation, Iron, Japan, Manganese, Mercury, Tissue analysis, Zinc.

Concentrations of four essential elements (Fe, Mn, Zn, and Cu) and two toxic metals (Cd and Hg) were measured in selected tissues of 19 pelagic seabird species collected in the North Pacific and neighboring waters. Essential metal concentrations were generally highest in the liver and less variable than toxic metals among species and also within each species. Fe concentrations in the muscle were higher in Alcidae than in the other families, whereas the opposite trend was found for Fe and Mn in the liver. Zn concentrations varied among species,

depending on the Cd concentrations. On the other hand, toxic metal concentrations were highest in the liver or kidney and varied widely among species, greatly depending on differences in the diet among species. Extraordinarily high Hg concentrations were found in Black-footed Albatrosses, Diomedea nigripes, exceeding 300 microg/g wet weight in some, and seemed to be due to constraints on the elimination of Hg. Also, some geographical differences in Cd and Hg concentrations of the seabirds were observed. The study areas in the North Pacific ocean are far from industrial sites, but they are on both the sea areas around Japan and the eastern Gulf of Alaska, where volcanic activity and ocean dumping occur. This, however, cannot be the main cause of high metal levels in the North Pacific seabirds, because species with local feeding habits have less, and not more, metals in their tissues than do wide-ranging species. The concentrations of Cd and Hg reported in this study appear to be natural rather than due to environmental pollution. (Author's abstract)
W91-04575

RECENT INFLUXES OF METALS INTO LAKE PEPIN, A NATURAL LAKE ON THE UPPER MISSISSIPPI RIVER.
Wisconsin Univ.-La Crosse. River Studies Center.
R. G. Rada, J. G. Wiener, P. A. Bailey, and D. E. Powell.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 712-716, September/October, 1990. 4 fig, 1 tab, 26 ref.

Descriptors: *Heavy metals, *Minnesota, *Mississippi River, *Path of pollutants, *Sediment contamination, *Water pollution sources, Aluminum, Cadmium, Chromium, Copper, Cores, Lake Pepin, Lead, Nickel, Radioactive dating, Spatial variation, Zinc.

The recent chronology of metal deposition was examined in Lake Pepin, a large natural lake on the Upper Mississippi River about 75 km downstream from the Minneapolis-St. Paul, Minnesota, metropolitan area. The lake, which has a high trapping efficiency for suspended sediments, serves as a sink for metals from industrial and domestic effluents discharged into the river. Sediment cores collected in 1981 from seven locations in the lake were analyzed for Cd, Cr, Cu, Ni, Pb, Zn, and Al (a reference element). Data of a core with Cs137 indicated that inputs of these metals increased markedly in the late 1950s, peaked in the early 1970s, and decreased in the late 1970s to 1981. Sediment enrichment factors decreased in the order Pb>Cd>Cu>/=Cr>Zn>Ni. The depth of the most highly contaminated strata in the core profiles decreased longitudinally from upstream to downstream--paralleling the upstream-to-downstream decrease in sedimentation rates. Changes in metal inputs to the lake would be most readily detected by analysis of sediments from the uppermost reaches, but the potential for release of sediment-associated metals to the water column is probably greatest in downstream reaches. The quality of water and sediments in the river between the Minneapolis-St. Paul metropolitan area and Lake Pepin has improved, but the surficial sediments remain measurably contaminated with metals and perhaps other toxic substances, posing unknown, but potential, risks to riverine biota. (Author's abstract)
W91-04576

SELENIUM AND OTHER ELEMENTS IN JUVENILE STRIPED BASS FROM THE SAN JOAQUIN VALLEY AND SAN FRANCISCO ESTUARY, CALIFORNIA.
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
M. K. Saiki, and D. U. Palawski.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 717-730, September/October, 1990. 2 fig, 6 tab, 54 ref.

Descriptors: *California, *Fish physiology, *Heavy metals, *Nonpoint pollution sources, *San Joaquin Valley, *Selenium, *Striped bass, *Water pollution sources, Agricultural runoff, Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Drainage water, Iron, Lead, Magnesium, Mercury, Molybdenum, Nickel, San Francisco Estuary, Strontium, Vanadium, Zinc.

Concentrations of selenium and other trace elements were determined in 55 whole body samples of juvenile anadromous striped bass (Morone saxatilis) from the San Joaquin Valley and San Francisco Estuary, California. The fish (</=1 yr old--the predominant life stage in the San Joaquin Valley) were collected in September-December 1986 from 19 sites in the Valley and 3 sites in the Estuary, and analyzed for the following elements: aluminum, arsenic, boron, barium, beryllium, cadmium, chromium, copper, iron, mercury, magnesium, molybdenum, nickel, lead, selenium, strontium, vanadium, and zinc. When compared to concentrations in whole freshwater fish measured by surveys from other waters, a few samples contained higher levels, of As, Cd, Cu, Pb, and Se. The median concentrations of Al, As, Cu, Fe, Mg, Se, and Sr also differed significantly (P</=0.05) among sites. However, only Se concentrations were highest (up to 7.9 microg/g dry wt) in samples from Valley sites exposed to agricultural subsurface (tile) drainwater; concentrations were lower in samples collected elsewhere. Water quality variables--especially those strongly influenced by tile drainwater (conductivity, total dissolved solids, total alkalinity, and total hardness)--were also significantly correlated (P</=0.05) with Se concentrations in fish. Selenium concentrations in striped bass from the Estuary were only one-fourth to one-half the concentrations measured in the most contaminated fish from the San Joaquin River. (Author's abstract)
W91-04577

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: CONCENTRATIONS OF ARSENIC, CADMIUM, COPPER, LEAD, MERCURY, SELENIUM, AND ZINC IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5G.
W91-04578

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: RESIDUES OF ORGANOCHLORINE CHEMICALS IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5G.
W91-04579

DEGRADATION STUDIES WITH 14C-FENOXAPROP IN PRAIRIE SOILS.
Agriculture Canada, Regina (Saskatchewan). Research Station.
A. E. Smith, and A. J. Aubin.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 343-350, August 1990. 1 fig, 3 tab, 18 ref.

Descriptors: *Fate of pollutants, *Herbicides, *Path of pollutants, *Soil contamination, Degradation products, Fenoxaprop, Fulvic acids, Humic acids, Persistence, Prairies, Saskatchewan.

The persistence of 14C-fenoxaprop acid, the major degradation product of the herbicide 14C-fenoxaprop-ethyl, was studied at different controlled temperature and moisture conditions in three Saskatchewan soils. At 85% of field capacity, degradation approximated to first-order kinetics at soil temperatures of 10, 20, and 30 C, with half-life values ranging from 42 to 5 d. In a clay at 20 C, there was no effect of moisture, between 50% and 100% field capacity, on the rate of 14C-fenoxaprop acid breakdown. There was no loss of radioactivity after 65-d in air dry soils. In all soils incubated at 85% field capacity and 20 C with 14C-fenoxaprop-ethyl, uniformly labeled in the chlorophenyl ring, there was evolution of 14CO2 indicating ring fission. Over a 56-d incubation period, 10-15% of the applied radioactivity was released from the treated soils as 14CO2. Extraction with ammoniated acetonitrile recovered 14-19% of the original radioactivity; between 3 and 5% of the initial 14C was incorporated into soil microbial biomass; and 17-25% into the fulvic acid, 7-12% into the humic acid, and 30-34% into the humin soil fractions. (Author's abstract)
W91-04584

USE OF FLUORESCENCE SPECTROSCOPY TO STUDY HERBICIDE-HUMIC ACID INTERACTIONS: PRELIMINARY OBSERVATIONS.
Agriculture Canada, Lethbridge (Alberta). Research Station.
B. M. Olson.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 515-518, August, 1990. 1 fig, 9 ref.

Descriptors: *Fate of pollutants, *Fluorescence spectroscopy, *Herbicides, *Humic acids, *Laboratory methods, *Path of pollutants, Copper, Hydrogen ion concentration, Paraquat, Scotland, Simetryn.

The use of fluorescence spectroscopy for the study of herbicide and humic acid interactions was investigated. Humic acid was extracted from Tillycorthie peat collected from a site near Pitmedden, Scotland. Fluorescence spectroscopy was then used to study the interaction of humic acid with Cu(2+), paraquat, and simetryn. Copper was selected to demonstrate the quenching effect of a metal ion on humic acid fluorescence. Paraquat was selected because of its permanent positive charge. Simetryn, on the other hand, is a member of the s-triazine herbicide group of weak bases. Depending on the pH, simetryn with a pKa of 4.0 can be either unprotonated or protonated. To compare the effects of the three solutes on the humic acid, fluorescence intensity values at 300 nm excitation wavelength were selected. At this wavelength the fluorescence intensities of the solutes and solvent were near zero. Paraquat and Cu(2+) quenched the fluorescence of humic acid by as much as 74 and 89%, respectively. Simetryn did not quench the fluorescence of humic acid, even at pH 4 under which conditions simetryn would have carried a positive charge due to protonation. The difference in electron acceptance may be important regarding other mechanisms of interaction between simetryn and humic acid such as hydrophobic bonding and H-bonding. (White-Reimer-PTT)
W91-04587

CONCENTRATIONS OF BORON, MOLYBDENUM, AND SELENIUM IN CHINOOK SALMON.
National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.
S. J. Hamilton, and R. H. Wiedmeyer.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 500-510, May 1990. 4 tab, 36 ref.

Descriptors: *Bioassay, *Boron, *Drainage water, *Fish physiology, *Heavy metals, *Molybdenum, *Nonpoint pollution sources, *Salmon, *Selenium, *Water pollution effects, Agricultural runoff, Brackish water, Chinook salmon, Freshwater, Selenate, Selenite, Survival, Well water.

The concentrations of boron, molybdenum, and selenium in young chinook salmon Oncorhynchus tshawytscha were determined in three partial life cycle chronic toxicity studies. In each study, fish were exposed to a mixture of boron, molybdenum, selenate, and selenite in the proportions found in subsurface agricultural drainage water in the basin of the San Joaquin Valley, California. Tests were conducted in well water and in site-specific fresh and brackish waters. No boron or molybdenum was detected in fish exposed to concentrations as high as 6,046 microg boron/L and 193 microg molybdenum/L for 90 d in well water or fresh water; however, whole-body concentrations of selenium increased with increasing exposure concentrations in well water and fresh water, but not in brackish water. Concentrations of selenium in chinook salmon were strongly correlated with reduced survival and growth of fish in well water and with reduced survival in a 15-d seawater challenge test of fish from fresh water. Concentrations

of selenium in fish seemed to reach a steady state after 60 d of exposure in well water or fresh water. Fish in brackish water had only background concentrations of selenium after 60 d of exposure, and no effects on survival and growth in brackish water or on survival in a 10-d seawater challenge test were exhibited. This lack of effect in brackish water was attributed to initiation of the study with advanced fry, which were apparently better able to metabolize the trace element mixture than were the younger fish used in studies with well water and fresh water. In all three experimental waters, concentration factors (whole-body concentration/waterborne concentration) for selenium decreased with increasing exposure concentrations, suggesting decreased uptake or increased excretion, or both, of selenium at the higher concentrations. (Author's abstract)
W91-04590

SELENIUM IN WETLANDS AND WATERFOWL FOODS AT KESTERSON RESERVOIR, CALIFORNIA, 1984.
Oregon Cooperative Fishery Research Unit, Corvallis.
C. A. Schuler, R. G. Anthony, and H. M. Ohlendorf.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 845-853, 1990. 3 fig, 3 tab, 47 ref.

Descriptors: *California, *Food chains, *Kesterson Reservoir, *Path of pollutants, *Plant tissues, *Sediment contamination, *Selenium, *Waterfowl, *Wetlands, Agricultural runoff, Animal tissues, Aquatic insects, Bioaccumulation, Saline water, Seasonal variation, Tissue analysis, Water pollution effects.

Kesterson Reservoir (Kesterson, CA) received subsurface agricultural drainwater containing high levels of salts and selenium from farmland in the San Joaquin Valley of California. The accumulation of selenium in wetlands and waterfowl foods at Kesterson was investigated during May, August, and December of 1984. High concentrations of selenium were found in water sediments, terrestrial and aquatic vegetation, and aquatic insects. Mean selenium concentrations in aquatic plants and insects ranged from 1.5 to 170 micrograms/g dry weight and were about 11 to 290 times those found at a nearby reference site. Concentrations in some waterfowl food plants and insects at Kesterson were up to 64 times those reported to be a health hazard to birds. Selenium concentrations were more seasonally variable in aquatic plats than in aquatic insects. Few differences in selenium accumulation were found among ponds. Deposition of selenium in plant parts was not uniform; rhizomes contained higher concentrations than seeds, and leaves were intermediate. Most biota bioaccumulated maximum selenium concentrations that were 1000 to nearly 5000 times the concentration in water. (Author's abstract)
W91-04613

CADMIUM ACCUMULATION AND METALLOTHIONEIN-LIKE PROTEINS IN THE SEA STAR ASTERIAS RUBENS.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
P. J. den Besten, H. J. Herwig, D. I. Zandee, and P. A. Voogt.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 858-862, 1990. 4 fig, 1 tab, 21 ref.

Descriptors: *Bioaccumulation, *Bioassay, *Cadmium, *Echinoderms, *Metallothioneins, *Path of pollutants, *Proteins, Animal tissues, Chronic exposure, Heavy metals, Kinetics, Sublethal effects, Tissue analysis, Toxicity, Water pollution effects.

Sea stars were exposed for four months to cadmium at 50 micrograms Cd/L. The cadmium content of stomachs, pyloric caeca, gonads and body wall was determined after 2, 4, 6, 8, and 16 weeks of exposure. The highest accumulation rates were found for body wall and pyloric caeca. The lowest accumulation rate was found for the gonads. In all tissues cadmium accumulation showed saturation kinetics. The body wall contained the largest part of the accumulated cadmium. Sephadex G-75 gel filtration experiments demonstrated the presence of metal-binding, metallothionein (MT)-like proteins with a molecular weight of 10.8 kD in cytosolic fractions of pyloric caeca from unexposed sea stars. The MT-like proteins contained mainly zinc and a small amount of copper. During exposure, the MT-like proteins accumulated cadmium at a relatively high rate, but a steady state was reached after 8 weeks, indicating that in vivo, the Cd-binding capacity of theses proteins was limited. When pyloric caeca cytosol from unexposed sea stars was incubated with cadmium in vitro, the MT-like proteins could bind larger amounts of cadmium than in vivo during the Cd exposure. After 16 weeks of Cd exposure, the in vitro Cd-binding capacity had hardly increased. Low-molecular-weight metal-binding proteins were absent in cytosolic fractions of the testes, ovaries and oocytes from Cd-exposed sea stars, even after four months of exposure. The cadmium accumulated in the gonads was bound exclusively to high-molecular-weight proteins, which accumulated cadmium at a relatively low rate, compared to the MT-like proteins in the pyloric caeca. The absence of MT-like proteins in the gonads may explain the low cadmium accumulation rates found for theses organs, but as a consequence, the accumulated cadmium is not detoxified. (Author's abstract)
W91-04615

EFFECTS AND FATE OF CADMIUM DURING TOXICITY TESTS WITH CHIRONOMUS RIPARIUS; THE INFLUENCE OF FOOD AND ARTIFICIAL SEDIMENT.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W91-04617

CADMIUM BIOAVAILABILITY TO THREE ESTUARINE ANIMALS IN RELATION TO GEOCHEMICAL FRACTIONS TO SEDIMENTS.
Old Dominion Univ., Norfolk, VA. Dept. of Geophysical Sciences.
J. H. Rule, and R. W. Alden.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 878-885, 1990. 10 fig, 1 tab, 33 ref.

Descriptors: *Bioaccumulation, *Bioavailability, *Cadmium, *Estuarine environment, *Estuarine sediments, *Grass shrimp, *Path of pollutants, *Polychaetes, *Sea mussels, *Sediment contamination, Animal tissues, Geochemistry, Heavy metals, Mortality, Sediment analysis, Statistical models, Tissue analysis, Toxicity.

The effects of sediment characteristics and geochemical fractions on the biological availability of cadmium to estuarine animals were studied. Grass shrimp (Palaemonetes pugio), blue mussels (Mytilus edulis) and a polychaete (Nereis virens) were exposed to Cd-treated sediment for 14 days. The test populations were evaluated for mortalities, oxygen consumption (except N. virens), and bioaccumulation of Cd. Sediment Cd was extracted sequentially to determine the exchangeable (EP), easily reducuble (ERP), organic-sulfide (OSP), moderately reducible (MRP), and acid extractable (AEP) geochemical phases. The shrimp displayed significant respiration effects; shrimp and mussels bioaccumulated Cd, particularly in the Cd-sand treatments. The polychaete did not bioaccumulate Cd. The OSP contained the greatest concentrations of Cd in all treatments. The Cd-sands were characterized by relatively higher levels of EP and ERP than for silts or clays. The EP and ERP fractions of all sediments were directly related to the Cd body burdens of the test species. A statistical model was developed that describes the bioaccumulation of Cd as a function of EP and ERP geochemical fractions of sediment Cd for M. edulis. There appeared to be a finite amount of Cd which could be incorporated into the ERP, since these concentrations were very similar for both treatment levels and most of the additional Cd in the higher treatment partitioned into the OSP. Analytical protocols focusing upon these easily extractable fractions will provide a more ecologically realistic picture of the significance of metals contamination than will bulk sediment analyses or those using strong extraction techniques. (Author's abstract)
W91-04618

ASSIMILATION OF POLYCHLORINATED BIPHENYLS BY A MARINE MOLLUSC AND COMPARISON WITH A RAT.
State Univ. of New York at Albany. School of Public Health.
B. Jahan-Parwar, L. W. Wood, and B. Bush.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 944-951, 1990. 3 fig, 3 tab, 34 ref.

Descriptors: *Animal metabolism, *Bioaccumulation, *Gastropods, *Metabolites, *Mollusks, *Path of pollutants, *Polychlorinated biphenyls, *Rodents, Algae, Animal tissues, Bioassay, Comparison studies, Fate of pollutants, Structure-activity relationships, Tissue analysis.

The marine mollusc Aplysia californica was fed seaweed Rhodymenia palmata contaminated with polychlorinated biphenyls (PCBs) at a high (experimental) and low (control) level for a period of 18 days in flow-through systems which limited the animals to dietary uptake. The assimilation of PCBs, determined by subtraction of fecal output from food intake, was greater at the high dosage (94 +/-29%) than at the low dosage (84 +/-22%). Assimilation selectivity of the different congeners favored those with lower chlorine content, and discriminated against those chlorinated in the para position on one of the rings. After assimilation, selectivity for incorporation into the hepatopancreas favored those congeners with higher chlorine contents over those with but 1 to 3 chlorines on the molecule. Similarities between incorporation into the liver of rats and into the hepatopancreas of Aplysia were found, suggesting that common mechanisms for bioaccumulation, and by extension, physiological effects, may be present in such diverse species of the animal kingdom. (Author's abstract)
W91-04623

INDOOR RADON AND WELL WATER RADON IN VIRGINIA AND MARYLAND.
George Mason Univ., Fairfax, VA. Center of Basic and Applied Science.
D. G. Mose, G. W. Mushrush, and C. Chrosniak.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 952-956, 1990. 4 fig,5 tab, 13 ref.

Descriptors: *Air pollution sources, *Domestic water, *Groundwater pollution, *Maryland, *Path of pollutants, *Radioactivity, *Radon, *Soil gases, *Virginia, Hazard assessment, Housing, Monitoring, Seasonal variation, Water pollution.

The domestic use of radioactive water has long been a cause for concern, but only a few studies have examined prolonged exposure to radionuclide concentrations found in natural settings. This paper reports on the indoor radon concentrations from 1500 homes in northern Virginia and southern Maryland and well water radon from 700 homes in the same area. Indoor radon concentrations are almost all between 1 and about 40 pCi/L. Differences in weather, basement wall construction, and home heating system influence indoor radon derived from the soil. The winter season shows the highest values with about 25% of the homes over this level. This seasonal variation is related to home ventilation. Waterborne radon in homes with private well ranges from about 100 pCi/L to about 8000 pCi/L. In small homes, indoor radon can be significantly increased by outgassing of the home water supply, even at water radon levels of less than 10,000 pCi/L. This was examined by monitoring radon levels in a 50 square foot bathroom in which the shower was left on for several hours. There was a significant increase in radon levels, from 29 to 350 pCi over a 5 hour period. The extent to which the waterborne radon concentration affects the concentration of indoor radon is

determined by the volume of the home, in combination with the radon content of water used in the home. (Author's abstract)
W91-04624

ACIDITY AS A FACTOR IN LEACHING OF COPPER, CHROMIUM AND ARSENIC FROM CCA TREATED DIMENSION LUMBER.
Guelph Univ. (Ontario). Dept. of Environmental Biology.
J. E. Warner, and K. R. Solomon.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1331-1337, 1990. 5 fig, 3 tab, 19 ref.

Descriptors: *Acid rain, *Acid rain effects, *Acidic water, *Arsenic compounds, *Chromium, *Copper, *Leaching, *Lumber, *Path of pollutants, *Wood preservatives, Atomic absorption spectroscopy, Environmental impact, Hardwood, Heavy metals, Infiltration, Preservation.

Because of the problems and restrictions associated with organic wood preservatives, inorganic preservative chemicals, especially the CCA (chromated copper arsenate) compounds, are frequently used. The purpose of this study was to establish the magnitude of worst case leaching events that can be expected to occur with CCA-treated materials available for public and commercial use. Samples of new and weathered utility lumber pressure-treated with chromated copper arsenate were tested for leaching of copper, chromium and arsenic by submersion in leaching baths of various pH levels. Accumulation of metals was monitored in leachate at pH 3.5, 4.5, 5.5, 7.0 and 8.5 over a period of 40 days by atomic absorption spectroscopy. Copper, chromium and arsenic were found in the leachate of both new and weathered wood with significantly higher levels of all metal occurring at acidic pH levels. Up to 100% of CCA treatment metals were found to have leached at pH 3.5, whereas a maximum of 9% of metals leached at pH 8.5. Metal leaching was found to be higher in citric acid than in dilute sulfuric acid solutions. Leaching of copper, chromium and arsenic was not proportional to the amount of metal present before leaching. Although it is too early to fully assess the toxicological significance of the use of CCA-treated wood in the environment, this study suggests that leaching of metals from treated wood in acidic waters (natural or resulting from acidic precipitation) may present an unacceptable environmental risk. (Author's abstract)
W91-04625

AQUATIC ENVIRONMENTAL FATE OF NITROGUANIDINE.
SRI International, Menlo Park, CA. Chemistry Lab.
W. R. Haag, R. Spanggord, T. Mill, R. T. Podoll, and T. W. Chou.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1359-1367, 1990. 6 fig, 3 tab, 17 ref. US Army Medical Research and Development Command Contract DAMD17-84-C-4252.

Descriptors: *Aquatic environment, *Biodegradation, *Explosives, *Fate of pollutants, *Nitroguanidine, *Path of pollutants, *Photolysis, Anaerobic bacteria, Bioaccumulation, Degradation, Metabolites, Nitrogen compounds, Oxidation.

Nitroguanidine (NQ) is a propellant used in military operations which may enter the aquatic environment during its production, use or disposal. It was determined that the environmental fate of NQ in surface waters is dominated by photolysis with surface half-lives at 40 degrees North latitude ranging from 0.6 days in summer to 2.3 days in winter. The environmental quantum yield is 0.01. The NQ is initially photolyzed to nitrite and hydroxyguanidine; nitrite is photochemically converted to nitrate, and hydroxyguanidine undergoes sensitized photolysis to unknown products. The photooxidation of nitrite is assisted by organic material in a process not involving hydrogen peroxide or singlet oxygen. Nitroguanidine biotransforms cometabolically; in the absence of extra organic nutrients the second-order rate constant was (3.8 +/-0.9) x 10 to the minus 10 power mL/cell/hour. Half-life estimates for aerobic, aquatic biotransformation range from 1 to 100 days. Cyanamide appears to be an end product of NQ use and no intermediate biotransformation products were observed. Nitroguanidine is expected to move readily through soils (soil sorption coefficient K sub p $<$ 0.1); however, anaerobic biotransformation occurs readily in soil, with an estimated half-life of 4 days. Other fate parameters measured at 25 C are a water solubility of 2600 +/-100 ppm, octanol/water partition coefficient of 0.148 +/-0.001, Henry's constant of $<$ .000007, base hydrolysis constant of 0.3 +/-0.1 millimoles/sec, neutral hydrolysis constant $<$ or = 0.02 micromoles/sec, and biouptake constants of 110 g dry cells/g water for Anabena flos-aquae and 150 g dry cells/g water for Selenastrum capricornutum. (Author's abstract)
W91-04627

USE OF BIODEGRADATION DATA IN CHEMICAL ASSESSMENT.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
R. J. Shimp, R. J. Larson, and R. S. Boethling.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1369-1377, 1990. 6 fig, 24 ref.

Descriptors: *Biodegradation, *Environmental impact, *Fate of pollutants, *Path of pollutants, *Risk assessment, Data interpretation, Hazard assessment, Kinetics, Model studies, Pollution load.

Biodegradation is an important removal mechanism for consumer product chemicals released in large volumes to aquatic and terrestrial environments. It results in a decrease in the mass or load of chemicals present in the environment and is key in preventing accumulation and persistence of chemicals. Although biodegradation is an important process in minimizing potentially adverse impacts on environmental systems, it has not been traditionally considered quantitatively in environmental assessments. Efforts to use such data have principally focused on either wholly qualitative evaluation of a material's biodegradation properties (e.g., 'fast' or 'slow'), or rigorous quantitative models to predict exposure concentrations in particular settings. This paper outlines an alternative approach which provides a semi-quantitative analysis combining biodegradation rate data with an assessment of environmental exposure. The approach is a generic one that relates biodegradation half-lives to rates of transport and residence times in specific environmental compartments (e.g., agricultural soil, rivers). It establishes the kinetic criteria needed to make biodegradation a 'practically significant' removal mechanism in a given environmental compartment. It is broadly applicable to chemicals which exhibit pseudo first order biodegradation kinetics at realistic environmental concentrations. (Author's abstract)
W91-04628

BIOTRANSFORMATION ACTIVITIES OF FERAL FISH IN WATERS RECEIVING BLEACHED PULP MILL EFFLUENTS.
Kuopio Univ. (Finland). Dept. of Physiology.
For primary bibliographic entry see Field 5A.
W91-04631

EFFECTS OF ACIDIC PRECIPITATION ON THE WATER QUALITY OF STREAMS IN THE LAUREL HILL AREA, SOMERSET COUNTY, PENNSYLVANIA, 1983-86.
Geological Survey, Harrisburg, PA.
For primary bibliographic entry see Field 5C.
W91-04636

PLAN OF STUDY FOR SELECTED TOXIC SUBSTANCES IN THE CALCASIEU RIVER, LOUISIANA.
Geological Survey, Baton Rouge, LA.
D. K. Demcheck, C. R. Demas, and P. B. Curwick.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Open-File Report 90-148, 1990. 29p, 5 fig, 5 tab, 11 ref.

Descriptors: *Calcasieu River, *Data acquisition, *Data requirements, *Louisiana, *Path of pollutants, *Toxic wastes, Ammonia, Benzenes, Bioaccumulation, Biodegradation, Chromium, Clams, Crabs, Fish, Heavy metals, Iron, Mercury, Naphthalenes, Nitrates, Nitrites, Sediment contamination, Streamflow.

In 1984 the U.S. Geological Survey established the Toxic Substances Hydrology, Surface-Water Contamination Program. As part of this program, an investigation of the lower Calcasieu River, Louisiana, began in 1985 to define the magnitude and distribution of selected toxic substances in the Calcasieu River and the physical and chemical processes that govern their fate. The major elements of the investigation are: (1) a compilation of previous studies of the Calcasieu River by various Federal, State, and local agencies; (2) reconnaissance surveys of chemical constituents in the water column and bottom material; (3) a remobilization study to determine how strongly semivolatile organic compounds are bound to bottom material and whether, upon exposure to waters with varying concentrations of dissolved solids, they dissolve into the water column; (4) a study of microbial degradation to determine whether anaerobic bacterial activity is a significant factor in the fate of semivolatile organic compounds in the bottom materials; (5) studies of the presence of synthetic organic compounds in the tissues of fish, clams, and crabs to determine if bio-accumulation of these compounds is occurring; (6) volatilization studies of compounds such as bromoform and chloroform to determine the relative importance of dilution and volatilization in the partitioning of the environment; (7) sediment-water interface studies to determine the rate of upward water movement through the bottom material to estimate on-bottom residence time and instream concentrations of selected soluble compounds; and (8) the development of a streamflow model to provide a hydrologic framework for water quality analysis. Preliminary results were used to select for intensive study of the following substances in water, bottom material, and biota: ammonia, nitrite plus nitrate, chromium, iron, mercury, bromoform, chloroform, 1,2-dichloroethane, hexachlorobenzene, hexachlorobutadiene, naphthalene, octachloronaphthalene, benzopyrene, and benzoperylene. (Author's abstract)
W91-04637

SUSPENDED-SEDIMENT DATA IN THE UPPER RIO GRANDE DE LOIZA BASIN, PUERTO RICO.
Geological Survey, San Juan, PR.
For primary bibliographic entry see Field 2H.
W91-04640

GROUND-WATER QUALITY NEAR A SCAVENGER-WASTE-DISPOSAL FACILITY IN MANORVILLE, SUFFOLK COUNTY, NEW YORK, 1984-85.
Geological Survey, Syosset, NY. Water Resources Div.
M. P. Scorca.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 88-4074, 1990. 45 p, 16 fig, 4 tab, 31 ref, 3 append. Prepared in cooperation with the Town of Brooklyn.

Descriptors: *Geochemistry, *Groundwater quality, *Infiltration basins, *Path of pollutants, *Wastewater disposal, Benzenes, Calcium, Chlorides, Dissolved solids, Glacial aquifers, Glacial sediments, Magnesium, Monitoring, New York, Potassium, Sodium, Specific conductivity, Water quality.

Sludge from sewage treatment plants and septic tanks was discharged to unlined infiltration basins at a scavenger-waste-disposal facility in Manorville, in south-central Suffolk County, New York, during 1964-82, and solid waste was accepted during 1960-72. Three test borings were made at the site and groundwater samples collected in 1984

and 1985 to examine the effects of the waste on local groundwater quality in the upper glacial aquifer. The test borings reveal that 180 to 205 ft of well-sorted glacial outwash sediments overlie deposits of the Matawan Group and Magothy Formation, undifferentiated. A sandy facies of the Gardiners Clay may be present in the southern half of the 0.88-sq-mi study area. Observation wells were installed in clusters along flow lines hydraulically downgradient from the facility, and water samples were collected from 29 wells in 1984 and from 63 wells in 1985. Geochemical data indicate that a 1,300-ft-wide plume of contaminated water has moved 4,700 ft downgradient from the disposal site. Samples of plume water had higher specific conductance, lower dissolved oxygen concentrations, and higher concentrations of dissolved solids, chloride, sodium, calcium, potassium, magnesium, and chlorobenzene than did samples from uncontaminated areas. The median background dissolved solids concentration of 23 mg/L (milligrams per liter) in water from wells in areas unaffected by the plume is considerably lower than the median concentration of 190 mg/L for plume water, which indicates that dissolved solids concentration and specific conductance are useful indicators of the plume's extent. Dissolved iron concentrations in groundwater are elevated for at least 1,400 ft downgradient from a site as a result of chemical (oxidation-reduction) alteration to the more soluble ferrous state. The geochemical condition of groundwater near this facility shows general similarities and particular differences to previously studied landfills located in glacial outwash deposits. (Author's abstract)
W91-04647

SUPERFUND RECORD OF DECISION: PERDIDO GROUNDWATER, AL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-04648

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 70--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W91-04650

STORAGE TANK MONITORING (EXCLUDES RADIOACTIVE WASTE STORAGE TANKS) (JAN 76--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5A.
W91-04652

CONTINUOUS AND PASSIVE ENVIRONMENTAL RADON MONITORING: MEASURING METHODS AND HEALTH EFFECTS (JAN 75--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5A.
W91-04654

BIODEGRADATION OF PESTICIDES (DEC 85--MAY 90).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-871989. Price codes: N01 in paper copy, N01 in microfiche. June 1990. 97p.

Descriptors: *Bibliographies, *Biodegradation, *Fate of pollutants, *Pesticides, *Wastewater treatment, Carbamates, DDT, Enzymes, Fungicides, Herbicides, Malathion, Microbial degradation, Organophosphorus pesticides, Parathion, Path of pollutants, Rodenticides, Waste treatment.

This bibliography contains citations concerning the biological degradation of pesticides. Pesticides such as malathion, parathion and DDT, organophosphates and carbamates, herbicides, fungicides, and rodenticides are examined. The isolation of enzymes specifically able to degrade pesticides, field studies of natural degradation and migration of pesticides, and test tube examination of microbial organisms with the ability to digest pesticides are covered. Degradation products, effects of available nutrients on microbial degradation, and pesticide resistance in natural ecosystems are also among the topics discussed. (This updated bibliography contains 237 citations, 30 of which are new entries to the previous edition.) (Author's abstract)
W91-04657

BIODEGRADATION OF PESTICIDES AND HERBICIDES (MAR 78--MAR 90).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W91-04659

SUBSOIL PERCOLATION OF SEWAGE: PURIFICATION EFFICIENCY OF UNSATURATED ZONE AND MASS BALANCE OF ORGANIC LOAD.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
For primary bibliographic entry see Field 5D.
W91-04711

NITZSCHIA PSEUDODELICATISSIMA: A SOURCE OF DOMOIC ACID IN THE BAY OF FUNDY, EASTERN CANADA.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
For primary bibliographic entry see Field 2L.
W91-04720

INFLUENCE OF CHLORINE SULSTITUTION PATTERN ON THE DEGRADATION OF POLYCHLORINATED BIPHENYLS BY EIGHT BACTERIAL STRAINS.
General Electric Corporate Research and Development, Schenectady, NY.
D. L. Bedard, and M. L. Haberl.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 87-102, 1990. 3 fig, 3 tab, 18 ref.

Descriptors: *Alcaligenes, *Biodegradation, *Corynebacterium, *Polychlorinated biphenyls, *Pseudomonas, Bacteria, Fate of pollutants, Microbial degradation.

The metabolism of eight di-and tri-chlorobiphenyls by eight bacterial strains was compared. The polychlorinated biphenyl (PCB) congeners used were 2,3-, 2,3'-, 2,4'-, 3,3'-,2,3,3'-, 2,4,4'-, 2,5,3'-, and 3,4,2'-chlorobiphenyl. The bacterial strains used were Corynebacterium sp. MB1, Alcaligenes strains A. eutrophus H850 and A. faecalis Pi434, and Pseudomonas strains LB400 and H1130, P. testosteroni H430 and H336, and P. cepacia H201. Both the relative rates of primary degradation of PCBs and the choice of the ring attacked were dependent on the bacterial strain used. The bacterial strains exhibited considerable differences in their relative reactivity preferences for attack on mono-and dichlorophenyl groups and in the degree to which the attack was affected by the chlorine substitution pattern on the nonreacting ring. For MB1 the reactivity pattern was 3-chlorophenyl > or = 4-chlorophenyl >> 2-chlorophenyl with no attack on 2,4-chlorophenyl or 2,5-chlorophenyl groups. Strains H1130, H430, H201, and Pi434 exhibited the same reactivity preferences as MB1, but for these strains (and for all others tested) the chlorination pattern on the nonreacting ring had a strong effect. For strain H336 the reactivity preference was 4-chlorophenyl > or = 2-chlorophenyl > 2,4-chlorophenyl > or = 3-chlorophenyl, with no evidence of attack on 2,5-chlorophenyl rings. For strains H850 and LB400 the relative reactivity was 2-chlorophenyl > 2,5-chlorophenyl > 3-chlorophenyl >> 2,4-chlorophenyl > 4-chlorophenyl. It is suggested that the eight bacterial strains represent four distinct classes of biphenyl/PCB-dioxygenase activity. Products formed were largely strain-independent and were determined primarily by the chlorine substitution pattern on the reacting ring. When the reacting ring was an unsubstituted phenyl or a 2-chlorophenyl group, the products were chlorobenzoic acids in high yields; for a 3-chlorophenyl ring, both chlorobenzoic acids and chloroacetophenones in moderate yields; and for a 4-chlorophenyl or 2,4-chlorophenyl group, chlorobenzoic acids in low yields with an apparent accumulation of meta ring-fission product. Strains H850 and LB400 degraded the 3-chlorobenzoic acid that they produced from the degradation of 2,3'-chlorobiphenyl. (Author's abstract)
W91-04727

ISOLATION AND PARTIAL CHARACTERIZATION OF A CLOSTRIDIUM SPECIES TRANSFORMING PARA-HYDROXYBENZOATE AND 3,4-DIHYDROXYBENZOATE AND PRODUCING PHENOLS AS THE FINAL TRANSFORMATION PRODUCTS.
Georgia Univ., Athens. Dept. of Microbiology.
X. Zhang, and J. Wiegel.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 103-121, 1990. 10 fig, 61 ref. Department of Energy Grant DE-FG09-86ER13614.

Descriptors: *Aromatic compounds, *Biodegradation, *Chlorinated hydrocarbons, *Clostridium, *Fate of pollutants, *Hydrocarbons, *Lake sediments, *Mineralization, *Phenols, Fermentation, Microbial degradation.

Organisms present in methanogenic freshwater lake sediments from the vicinity of Athens, Georgia, were adapted to mineralize 2,4-dichlorophenol. Repeated addition of 0.5 to 2.7 mmol/L of phenol, and later of 0.5-6.2 mmol/L p-hydroxybenzoate (p-OHB), to such enrichments led to the conversion of p-OHB to phenol at a rate of up to 100 mmol p-OHB/L/day. Subsequently, a spore-forming, obligately anaerobic bacterium, strain JW/Z-1, was isolated which transformed p-OHB to phenol and 3,4-dihydroxybenzoate (3,4-OHB) to catechol (1,2-dihydroxybenzene) stoichiometrically without further metabolism of the phenols. The strain did not transform benzoate, 4-chlorophenol, 2,4-dichlorophenol, 4-chlorobenzoate, o-and m-hydroxybenzoate, 2,4-and 3,5-dihydroxybenzoate, 2,3,4-and 2,4,5-trihydroxybenzoate, or 4-aminobenzoate. Yeast extract was required for growth of strain JW/Z-1 and only high concentrations of casein hydrolysate or tryptone could substitute it, to some extent. Except for sodium acetate, and some amino acids together with a 20-fold increased concentration of vitamins, no single carbohydrate or defined organic compound has been found to support growth of this strain in the presence (or in the absence) of 0.2 to 0.5% (w/v) yeast extract. The fermentation products during growth on yeast extract indicated that the metabolism of amino acid degradation was the major source for growth. The decarboxylating activity was inducible by p-OHB for the decarboxylation of p-OHB, and at a lower rate for 3,4-OHB, and by 3,4-OHB only for 3,4-OHB, suggesting that two different enzyme systems exist. The addition of the aromatic amino acids phenol or benzoate did not induce the decarboxylation activity in cultures growing with yeast extract. Growth was observed at temperatures ranging from 12-41 C (T opt, 33-34 C) and at pH-values ranging from 6.0-10.0 (pH opt, 7.2-8.2). The shortest doubling time observed for strain JW/Z-1 was 3.2 hr. (Author's abstract)
W91-04728

ANAEROBIC BIODEGRADATION OF PARA-CRESOL UNDER THREE REDUCING CONDITIONS.
New York Univ. Medical Center, NY. Dept. of Microbiology.
M. M. Haggblom, M. D. Rivera, I. D. Bossert, J. E. Rogers, and L. Y. Young.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 141-150, 1990. 5 fig, 2 tab, 35 ref. EPA CR-814611 and NIEHS ESO4895.

Descriptors: *Anaerobic conditions, *Biodegradation, *Fate of pollutants, *Lake sediments, *Phenols, Aromatic compounds, Creosote, Culturing

techniques, Denitrification, Laboratory methods, Metabolism, Methanogenesis, Microbial degradation.

The anaerobic degradation of p-cresol, a common contaminant of groundwaters due to the use of creosote, was studied with one lake sediment source under three reducing conditions, namely denitrifying, sulfidogenic, and methanogenic. Loss of p-cresol (1mM) in all the anaerobic systems took initially 3 to 4 weeks. In acclimated cultures p-cresol was degraded in less than a week. p-Cresol was completely metabolized under denitrifying, sulfidogenic, and methanogenic conditions, with formation of nitrogen gas, loss of sulfate, and formation of methane and carbon dioxide, respectively. p-Cresol metabolism proceeded through p-hydroxybenzaldehyde and p-hydroxybenzoate under denitrifying and methanogenic conditions. These compounds were rapidly degraded in cultures acclimated to p-cresol under all three reducing conditions. These results suggest that the initial pathway of p-cresol degradation is the same under denitrifying, sulfidogenic, and methanogenic conditions and proceeds via oxidation of the methyl substituent to p-hydroxybenzaldehyde and p-hydroxybenzoate. The initial rate of p-hydroxybenzaldehyde degradation was high in both the unacclimated cultures and in the cultures acclimated to p-cresol, suggesting that this step is nonspecific. Benzoate was additionally detected as a metabolite following p-hydroxybenzoate in the methanogenic cultures, but not in the denitrifying or sulfidogenic cultures. The degradation pathway therefore may diverge after p-hydroxybenzoate formation depending on which electron acceptor is available. (Author's abstract)
W91-04729

EFFECT ON MINERAL MEDIA ON TRICHLOROETHYLENE OXIDATION BY AQUIFER METHANOTROPHS.
Stanford Univ., CA. Dept. of Environmental Engineering.
S. M. Henry, and D. Grbic-Galic.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 151-169, 1990. 4 fig, 4 tab, 42 ref. EPA grant CR 812220.

Descriptors: *Aquatic bacteria, *Aquifer restoration, *Biodegradation, *Fate of pollutants, *Oxidation, *Trichloroethylene, *Water pollution treatment, In situ treatment, Microbial degradation.

The effect of growth in different mineral media on subsequent oxidation of trichloroethylene (TCE) by type I and type II aquifer methanotrophs was evaluated. Mixed culture MM1, containing a type II methanotroph, and a type I pure culture tentatively identified as a Methylomonas sp., were enriched and isolated from an uncontaminated groundwater aquifer. The second-order rate coefficients for TCE oxidation by these cultures varied by more than an order of magnitude when the cultures were grown in different mineral media. The presence of a chelator (NaEDTA) in one of these media (Whittenbury) significantly enhanced rates of TCE oxidation by all the cultures tested. When pregrown in this mineral medium, the resting cells of the pure culture Methylomonas sp. MM2 exhibited second-order TCE oxidation rates as great as 0.78 L/mg/day, whereas when pregrown in Whittenbury lacking the chelator, the rates did not exceed 0.018 L/mg/day. The rate of TCE oxidation by Methylomonas sp. MM2 pregrown in another mineral medium devoid of chelators (Fogel) was 0.26 L/mg/day, and adding EDTA to this medium did not affect the rate. Adding 1.6 microM Cu to both Whittenbury and Fogel media reduced the TCE oxidation rates about an order of magnitude; subsequent addition of 84 microM EDTA partially alleviated this effect. The maximal rate for TCE oxidation by Methylomonas sp. MM2 were significantly higher, and the half saturation coefficients for TCE significantly lower, following growth in the presence of EDTA. Stationary phase TCE oxidation rates as great as 2.3 L/mg/day were achieved when Methylomonas sp. MM2, grown in Whittenbury medium, was provided formate as reducing agent. Omitting EDTA from Whittenbury medium also significantly reduced the methane oxidation rate and the growth yield. Cu addition did not significantly affect the methane oxidation rate or growth yield. The findings suggest that indigenous methanotrophs are capable of transforming TCE at rates suitable for bioremediation applications. (Geiger-PTT)
W91-04730

REDUCTIVE DECHLORINATION OF DICHLOROPHENOLS BY NONADAPTED AND ADAPTED MICROBIAL COMMUNITIES IN POND SEDIMENTS.
Technology Applications, Inc., Athens, GA.
D. D. Hale, J. E. Rogers, and J. Wiegel.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 185-196, 1990. 3 fig, 3 tab, 21 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Lake sediments, *Microbial degradation, *Phenols, Chlorinated hydrocarbons.

Fresh and dichlorophenol (DCP)-adapted sediments from two ponds near Athens, Georgia exhibited distinctly different dechlorinating activities. These differences centered on the relative rates of reductive dechlorination in both fresh and adapted sediments and on the substrate specificity of the adapted sediments. Fresh Cherokee Trailer Park Pond sediment dechlorinated 2,3-, 2,4-, and 2,6-DCP to monochlorophenols at a faster rate and after a shorter lag period than fresh Bolton's Pond sediment. Lag periods were not observed in either Cherokee or Bolton's sediments that had been adapted to dechlorinate either 2,3-, 2,4-, or 2,6-DCP. Adapted Cherokee sediments exhibited faster dechlorinating rates and a broader substrate specificity than the adapted Bolton's sediments. The broad substrate specificity of each of the adapted Cherokee sediments contrasted sharply with the narrow specificity of the 2,6-DCP-adapted Bolton's sediment. The preference for reductive dechlorination was ortho > meta or para in sediments from both ponds. (Author's abstract)
W91-04732

PHARMACOKINETIC MODELING IN AQUATIC ANIMALS: I. MODELS AND CONCEPTS.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
M. G. Barron, G. R. Stehly, and W. L. Hayton.
Aquatic Toxicology AQTODG, Vol. 18, No. 2, p 61-86, 1990. 3 fig, 2 tab, 60 ref.

Descriptors: *Aquatic animals, *Bioaccumulation, *Kinetics, *Mathematical models, *Model studies, *Pharmacokinetics, *Toxicology, Biotransformation, Fate of pollutants, Fish, Metabolism.

Pharmacokinetic modeling in aquatic animals using multicompartmental, clearance-based, non-compartmental and physiologically-based pharmacokinetic models should be considered as an alternative to traditional approaches, which assume that the animal acts as a single homogeneous compartment based on apparent monoexponential elimination. Multicompartmental models are a necessary increase in complexity when elimination is biphasic or when there is a widely different distribution between high perfusion and low perfusion tissues. Alternatives to traditional rate-constant based models are clearance-based compartmental models, which have parameters that may be interpreted in terms of the controlling physiological and biochemical processes. Compartmental models have been predominantly applied in aquatic toxicology. Non-compartmental methods characterize uptake, bioaccumulation, distribution, elimination, and persistence without making assumptions about the underlying model topology. Development of physiologically-based models is highly desirable because they allow extrapolation to other species, body sizes and environmental conditions. (Author's abstract)
W91-04733

BIOLOGICAL TRANSFORMATIONS OF 1,1,1-TRICHLOROETHANE IN SUBSURFACE SOILS AND GROUND WATER.
Dow Chemical Co., Midland, MI. Health and Environmental Sciences.
G. M. Klecka, S. J. Gonsior, and D. A. Markham.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 12, p 1437-1451, 1990. 6 fig, 2 tab, 44 ref.

Descriptors: *Biodegradation, *Biotransformation, *Chlorinated hydrocarbons, *Fate of pollutants, *Groundwater pollution, *Soil contamination, Alluvial aquifers, Microbial degradation.

1,1,1-Trichloroethane was readily degraded in samples from an alluvial aquifer under both methanogenic and sulfate reducing conditions. No lag period was noted prior to disappearance of the parent compound. Products detected in the reaction mixtures included 1,1-dichloroethane, chloroethane, 1,1-dichloroethene, acetic acid and carbon dioxide. No other chlorinated metabolites were detected. Biological reductive dehalogenation was responsible for the metabolism of 1,1,1-trichloroethane to 1,1-dichloroethane and to chloroethane. Abiotic transformations resulted in 1,1-dichloroethene and acetic acid. However, biological mechanisms also appeared to contribute to the formation of acetic acid, which was subsequently mineralized to carbon dioxide. Pseudo-first-order rate constants estimated for the biotransformation of 1,1,1-trichloroethane were in the range of 0.0034/day to 0.015/day, whereas the rate constant for abiotic degradation was approximately 0.0006/day. Biotransformation of the compound was not observed in aquifer samples under aerobic or denitrifying conditions. (Author's abstract)
W91-04743

PROTEIN-MEDIATED SELENIUM BIOMETHYLATION IN EVAPORATION POND WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
E. T. Thompson-Eagle, and W. T. Frankenberger.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 12, p 1453-1462, 1990. 2 fig, 3 tab, 38 ref. Federal-State San Joaquin Valley Drainage Program Contract No. 7-FC-20-05110.

Descriptors: *Biodegradation, *Bioremediation, *Methylation, *Path of pollutants, *Proteins, *San Joaquin Valley, *Selenium, Agricultural runoff, Evaporation ponds, Fate of pollutants.

The stimulatory properties of proteins and their components were examined with respect to biological selenium dissipation. Laboratory studies showed that Se biomethylation is protein-peptide-limited rather than nitrogen-, amino acid-, or carbon-limited. Crude casein and its components, delta, beta, and kappa-caseins and peptides (1 g carbon/L pond water) were equally stimulatory producing a >50-fold enhancement in demethylselenide (DMSe) yield. Dephosphorylation of casein resulted in a 57% reduction in Se volatilization. Dialysis studies indicated that the active ingredient of casein is likely to ba a peptide or peptide mixture. Casein did not appear to increase Se methylation through any physicochemical characteristics such as a change in pH or chelation of pond water ions. Alternative protein sources including cottonseed meal, cheese whey and yeast sludge dramatically increased methylation (29-fold, 300-fold and 42-fold, respectively) over unamended samples, with over 10% of the Se inventory converted into DMSe in 17 days. A single casein amendment (0.2 g C/L) to water columns in the field caused a 38% Se loss from the initial inventory of A San Joaquin Valley evaporation pond in 142 days. Under optimum conditions, protein-mediated deselenification of agricultural drainage water is a promising and novel bioremediation technique to permanently remove Se on site. (Author's abstract)
W91-04744

DIETARY ACCUMULATION AND SUSTAINED HEPATIC MIXED FUNCTION OXIDASE ENZYME INDUCTION BY 2,3,4,7,8-PENTACHLORODIBENZOFURAN IN RAINBOW TROUT.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5C.

W91-04745

MODELING TRANSFER OF CS137 FALLOUT IN A LARGE FINNISH WATERCOURSE.
Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Nuclear Engineering Lab.
R. Korhonen.
Health Physics HLTPAO, Vol. 59, No. 4, p 443-454, October 1990. 8 fig, 6 tab, 10 ref.

Descriptors: *Bioaccumulation, *Cesium radioisotopes, *Chernobyl accident, *Fallout, *Finland, *Path of pollutants, Lake Paijanne, Lakes, Model studies, Perch, Pike, Radioactive wastes, Roach.

Transfer of radioactive cesium (Cs137) fallout deposited onto the Kymijoki drainage area after the Chernobyl accident was calculated using the dynamic compartment model DETRA. The model includes a fish model for roach, nonpredatory and predatory perches, and pike. Fallout was assumed to consist of a soluble and insoluble component, behaving differently in the environment. Model predictions were compared with measured concentrations. Lake Paijanne, the largest lake of the watercourse, was studied most extensively. Calculated concentrations in lake water were consistent with measured concentrations. However, calculated concentrations in fish were lower than measured concentrations. To test the model by using additional experimental data, transfer of nuclear weapons testing fallout was also calculated. The processes that cause the rather rapid removal of Cs137 from lake water need to be studied further using more detailed data. In the long term, runoff and resuspension of sedimentary material were considered to be important in causing concentrations in lake water. (Author's abstract)
W91-04749

BIOTURBATION: A FACILITATOR OF CONTAMINANT TRANSPORT IN BED SEDIMENT.
Balsam Environmental Consultants, Inc., Salem, NH.
W. S. Bosworth, and L. J. Thibodeaux.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 211-217, November 1990. 7 fig, 1 tab, 48 ref.

Descriptors: *Benthos, *Bioturbation, *Path of pollutants, *Sediment contamination, *Spoil banks, *Water pollution control, Benthic environment, Benthic fauna, Bottom sediments, Sediment-water interfaces, Sediments, Soil contamination.

The biological activity of benthic organisms (bioturbation) in bed sediments can be significantly more important than physicochemical processes in the movement of sediment particles and interstitial constituents within the sediment column and to the overlying water. Bioturbation-driven transport processes may be several orders of magnitude more rapid than molecular-driven processes for some constituents (for example, particle reactive compounds like polychlorinated biphenyls) when considered on a chemical pore water concentration gradient basis. Benthic organisms affect particle redistribution and solute transport by burrowing, ingestion/excretion, tube-building and biodeposition. In most benthic environments, whether freshwater, estuarine or marine, numbers of organisms and rates of sediment turnover are highest in the oxygenated zone above the redox boundary, generally the top 2-5 cm of the sediment column. However, a variety of organisms penetrate deeper into the sediment and may also be important in transport of both dissolved and particle reactive constituents. When considering capping of contaminated sediment in place or capping of contaminated dredge spoils, the effects of bioturbation on the mobility of the contaminants must first be considered before establishing engineering design criteria. Capping of contaminated bed sediments or dredge spoils can elevate the bioturbated zone above the contaminated bed sediment and thus potentially reduce the rate of contaminant transport by several orders of magnitude. (Author's abstract)
W91-04765

RADIOACTIVE FALLOUT RECONSTRUCTION FROM CONTEMPORARY MEASUREMENTS OF RESERVOIR SEDIMENTS.
Department of Energy, New York. Environmental Measurements Lab.
P. W. Krey, M. Heit, and K. M. Miller.
Health Physics HLTPAO, Vol. 59, No. 5, p 541-554, November 1990. 7 fig, 5 tab, 22 ref.

Descriptors: *Cesium radioisotopes, *Fallout, *Lake sediments, *Radioactivity, *Sediment contamination, *Water pollution sources, Isotope studies, Nevada Test Site, Nuclear explosions, Southwestern United States, Watersheds.

The reconstruction of the radioactive fallout in the Southwestern U.S. from nuclear tests conducted at the Nevada Test Site has received considerable attention. The temporal history of atmospheric deposition to a watershed area can be preserved in the sediment of a lake or reservoir that is supplied by the watershed. The 137Cs and isotopic Pu concentrations with depth were determined in the sediments of two reservoirs, Enterprise and Deer Creek, which are located in widely separated regions of the state of Utah. The data not only reconstruct the history of the total radioactive fallout in the area, but also permit estimating the contributions from global sources and from the Nevada Test Site detonations in the 1950s. Although the two reservoirs studied were located in widely different regions of the state of Utah and were markedly different in their proximity to the Nevada Test Site, the estimate of the Nevada Test Site 137Cs deposition and of the integrated air exposure at each watershed were about the same at around 40 millibequerel/square cm, decay corrected to 1982 and .00026 C/kg, respectively. These results agree with earlier estimates of the Nevada Test Site 137Cs fallout and integrated air exposures in these areas. At the Enterprise Reservoir, results agree with the estimated exposure calculated from the postshot radiation monitoring conducted in the 1950s. In addition, there is consistent evidence that 239Pu + 240Pu fallout is more transportable from the watershed to the reservoir sediment than 137Cs at the two reservoirs studied. (Mertz-PTT)
W91-04775

DESORPTION KINETICS AND MOBILITY OF SOME RADIONUCLIDES IN SEDIMENTS.
Kyoto Univ., Osaka (Japan). Research Reactor Inst.
M. Fukui.
Health Physics HLTPAO, Vol. 59, No. 6, p 879-889, December 1990. 9 fig, 1 tab, 17 ref.

Descriptors: *Coastal waters, *Nuclear powerplants, *Path of pollutants, *Radioactive wastes, *Radioisotopes, *Sediment contamination, *Water pollution sources, Cesium radioisotopes, Coasts, Cobalt radioisotopes, Manganese radioisotopes, Strontium radioisotopes, Zinc radioisotopes.

It is important to predict the fate of radionuclides released from nuclear power plants in coastal areas for assessing the likely radiation exposure doses to the human population. Bottom sediments contaminated by radioactive trace metals may be ingested by fish with the prey. The desorption kinetics of five radionuclides, 85Sr, 137Cs, 60Co, 54Mn, and 65Zn, were studied for several coastal sediments, a few limnetic sediments, and one subsoil, using various aqueous solutions for extraction in batch systems. In a 2-week desorption experiment, >90% of most radionuclides sorbed were extracted by 6N-HCl, whereas in 1N-HCl about 30% of the 137Cs was retained within the sediments and soil due to its fixation following intraparticle diffusion. For longer desorption periods (6 weeks), reversible sorption with sediments could be seen for the 137Cs compared with the other four radionuclides in seawater. The EDTA-2Na solution extracted >70% of 65Zn, 54Mn, and 60Co, and the ammonium oxalate extracted >60% of 54Mn and 60Co. Readily exchangeable cations extracted by ammonium acetate were >80% for 85Sr, about 50% for 137Cs, and 40% for 60Co and 54Mn. Many of the distribution coefficients for these radionuclides in coastal sediments obtained by desorption experiments were one order of magnitude or more larger than those obtained by the adsorption experiments. For 85Sr, larger-than-expected distribution coefficients were obtained in the desorption experiments, an indication of the irreversible formation of metal-oxyhydroxides during a slow reaction. Using batch and column diffusion experiments, it was recognized that 60Co and 54Mn are less strongly associated with coastal sediments under suboxic conditions, and their migration rates are greater in deeper layers of sediment than in the top layer, an indication that a single kinetics model is inappropriate to forecast the behavior of radionuclides near sediment surface layers. (Mertz-PTT)
W91-04776

RADON IN THE HUMAN BODY FROM DRINKING WATER.
Alaska Univ., Fairbanks. Inst. of Marine Science.
T. A. Gosink, M. Baskaran, and D. F. Holleman.
Health Physics HLTPAO, Vol. 59, No. 6, p 919-924, December 1990. 1 fig, 2 tab, 22 ref.

Descriptors: *Bioaccumulation, *Drinking water, *Path of pollutants, *Radon, *Water pollution sources, Potable water, Public health, Radioisotopes, Water pollution.

Much attention has been given recently to the accumulation of 222Rn in buildings and the resulting potential health hazard from inhalation of short-lived daughters of Rn. More than half the U.S. population obtains its water from wells. From the several hundred analyses of public wells the average radon concentration is about 40 bequerel/L. Several studies have considered the water-derived radiation in household air delivered to the lungs or to the gastrointestinal tract. The direct contribution of radiation from Rn in drinking water to the entire body was examined. Radon from drinking water may not be rapidly eliminated by respiration and may remain in the body for 12 hours, depending on physical activity. The whole-body dose directly from water ingestion is usually less than 10% of the total dose from Rn and its short-lived daughters. However, radiation doses due to ingestion of water containing 370 bequerel/L Rn may be a great as 50% of the recommended limit for the general population. This is in addition to the nearly 1350 microsieverts annually delivered to the lungs in an average home from airborne short-lived Rn daughters, of which around 20% may be attributable to domestic water use other than drinking. These factors combine to yield 80% to 90% of either the 1700 microsieverts recommended limit for the general public or the 5000 microsievert/year recommended limit for individuals. (Mertz-PTT)
W91-04777

LEGIONELLA IN DUBLIN HOSPITAL WATER SUPPLIES.
Mater Misericordiae Hospital, Dublin (Ireland). Dept. of Microbiology.
For primary bibliographic entry see Field 5F.
W91-04778

ADSORPTION OF CHLORDIMEFORM BY HUMIC SUBSTANCES FROM DIFFERENT SOILS.
Instituto de Recursos Naturales y Agrobiologia, Seville (Spain).
C. Maqueda, E. Morillo, J. L. Perez Rodriguez, and A. Justo.
Soil Science SOSCAK, Vol. 150, No. 1, p 431-437, 1990. 6 fig, 2 tab, 12 ref.

Descriptors: *Adsorption, *Chlordimeform, *Fulvic acids, *Humic acids, *Path of pollutants, *Soil chemistry, Cation exchange, Functional groups, Pesticides, Soil types, Structure-activity relationships.

The interaction of the cationic pesticide chlordimeform with humic and fulvic acids from different soils was investigated. The humic acids used were extracted from four soils: two classified as typic Chromoxerert, one classified as Podsol, and one classified as Andosol. The fulvic acids used were from the Podsol and Andosol soils. The mechanism of chlordimeform adsorption is essentially a cation exchange reaction. Adsorption is influenced by the origin of the humic substances because of the different content in functional groups. Fulvic

acids adsorb in lower proportion than humic acids from the same soil, despite the higher content in functional groups. (Brunone-PTT)
W91-04798

CONTAMINATION OF SOIL WITH OILFIELD BRINE AND RECLAMATION WITH CALCIUM CHLORIDE.
Agricultural Research Service, Mandan, ND. Northern Great Plains Research Center.
For primary bibliographic entry see Field 5G.
W91-04799

TAMSHUI RIVER CLEANUP.
For primary bibliographic entry see Field 5D.
W91-04818

COMPARISON OF CAPILLARY PRESSURE--SATURATION RELATIONS FOR DRAINAGE IN TWO-AND THREE-FLUID POROUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2F.
W91-04825

PARALLEL COMPUTING FOR SOLUTE TRANSPORT MODELS VIA ALTERNATING DIRECTION COLLOCATION.
Wyoming Univ., Laramie. Dept. of Mathematics.
M. C. Curran, and M. B. Allen.
Advances in Water Resources AWREDI, Vol. 13, No. 2, p 70-75, 1990. 5 fig, 15 ref. NSF grant RII-8610680, EPA cooperative agreement CR813928-01-0, and ONR contract 0014-88-K-0370.

Descriptors: *Algorithms, *Collocation, *Computer programs, *Groundwater pollution, *Groundwater transport, *Model studies, *Parallel processing, *Solute transport, Alternating-direction collocation, Computers, Dimensional analysis.

The algorithmic aspects of an alternating-direction scheme for finite-element collocation, especially as implemented for the two-dimensional advection-diffusion equation governing solute transport in groundwater were examined and reviewed. The purpose of the alternating-direction collocation (ADC) method is to modify the ordinary two-dimensional collation procedure via an operator splitting. This splitting reduces the discrete problem to one involving a sequence of matrix equations, each of which has the same sparse structure as the one-dimensional collocation system. ADC was implemented on an Alliant FX/8 parallel processing computer. The Alliant allows users to control concurrency within a standard Fortran code through the use of compiler directives. From operation counts alone, it has been clear for some time that ADC offers distinct efficiencies over standard methods for two-dimensional collocation in a serial computing environment. With the advent of practical parallel computers, ADC hold even more promise, since the splitting scheme converts a fully two-dimensional problem into a sequence of 'one-dimensional' problems that are amenable to concurrent processing. Similar observations should hold for other alternating-direction methods, including techniques for multidimensional finite-difference and Galerkin approximations. (White-Reimer-PTT)
W91-04826

PARALLEL LEAST SQUARES COLLOCATION CONJUGATE GRADIENT APPROACH FOR THE ADVECTION DIFFUSION EQUATION.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 7C.
W91-04832

TASTE AND ODOR EPISODES AT WACHUSETT RESERVOIR.
Massachusetts Water Resources Authority, Boston. Harbor Studies Dept.
For primary bibliographic entry see Field 5F.
W91-04840

URBAN STORMWATER: AN OVERVIEW FOR MUNICIPALITIES.
Woodward-Clyde Consultants, Oakland, CA.
G. Boyd, and N. Gardiner.
Public Works PUWOAH, Vol. 121, No. 13, p 39-42, 72, December 1990. 2 tab.

Descriptors: *Path of pollutants, *Runoff, *Storm water, *Urban hydrology, *Urban runoff, Conveyance structures, Nutrients, Pollutant identification, Regulations, Sediments, Toxic materials.

A general background description of the major processes that lead to stormwater-related water quality problems is presented. During the past 20 years, the findings from several major research and demonstration programs have shown that urban stormwater typically contains pollutants that limit its subsequent use as a resource and/or may lead to impacts when it is discharged to receiving waters. The increased recognition of the pollution potential of urban stormwater has led to several important regulatory developments, including the following: (1) EPA has developed regulations that require municipalities and industries to apply for and obtain stormwater discharge permits under amended provisions of the National Pollutant Discharge Elimination System (NPDES); and (2) several EPA regional offices and state-level water quality control agencies have also initiated focused programs that have required certain designated municipal and industrial stormwater dischargers to define and describe their stormwater conveyance systems, and develop and implement practical programs for controlling stormwater quality. Therefore, it becomes necessary to identify the processes that create polluted stormwater. Major stormwater processes include atmospheric scrubbing, surface wash-off, erosion and scour, chemical transport, meteorological conditions, and watershed characteristics. The principal types of pollutants found in stormwater are sediment, oxygen demanding substances, nutrients, toxic substances, oil and grease, and bacteria. The general philosophy guiding the municipal stormwater regulations is that control strategies and programs should be site-specific, rather than generalized in their approach. (White-Reimer-PTT)
W91-04848

INDIANA WATER QUALITY, 1988. MONITOR STATION RECORDS, RIVERS AND STREAMS.
Indiana Dept. of Environmental Management, Indianapolis. Office of Water Management.
Indiana Department of Environmental Management, (1988). 160p, 1 append.

Descriptors: *Hydrologic data collections, *Indiana, *Monitoring, *Surface water data, *Water quality, *Water quality data, Bacterial analysis, Chemical properties, Microbiological studies, Physical properties, Plankton, Rivers, Streams, Surface water.

This is the thirty-first annual water quality report on the major surface waters of Indiana. In April 1957, the Division of Sanitary Engineering, Indiana State Board of Health, established 49 sites for the biweekly collection of samples for physical, chemical, and bacteriological analyses, and 10 of the stations were sampled for radiological analyses. Various changes and improvements have been made since the program was established in 1957. On April 1, 1986, the Indiana Department of Environmental Management assumed this program's duties. The report details the analyses conducted on the 105 stations that were included in the total 1988 program. Physical, chemical, and bacteriological analyses were made on samples collected from all 105 of these stations and plankton analyses from 40. (Lantz-PTT)
W91-04857

DATA ON POLYCHLORINATED BIPHENYLS, DIELDRIN, LEAD, AND CADMIUM IN WISCONSIN AND UPPER MICHIGAN TRIBUTARIES TO GREEN BAY, JULY 1987 THROUGH APRIL 1988.
Geological Survey, Madison, WI. Water Resources Div.
L. B. House.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-52, September 1990. 7p, 1 fig, 3 tab, 2 ref.

Descriptors: *Cadmium, *Green Bay, *Heavy metals, *Lead, *Michigan, *Polychlorinated biphenyls, *Water pollution sources, *Wisconsin, Tributaries.

The U.S. Geological Survey sampled the bottom sediment and water column of 11 streams tributary to western Green Bay for polychlorinated biphenyls, lead, and cadmium. Four of these streams also were sampled for dieldrin, a pesticide previously used in agricultural areas of the watershed. An additional 11 streams tributary to eastern Green Bay were sampled for dieldrin in the bottom sediment and storm runoff. Samples were collected from July 1987 through April 1988. The results of the sampling did not show the presence of detectable concentrations of dieldrin in the sampled tributaries. A low concentration of polychlorinated biphenyls (10 mg/kg) was found in the bottom sediment of Duck Creek, a western-shore tributary near the city of Green Bay. Lead (10 mg/kg) also was found in the bottom sediment of the Suamico River near the mouth. Lead (4 micrograms/L) was detected in the spring-runoff sample from the Fishdam River, a tributary from upper Michigan. (USGS)
W91-04861

PRELIMINARY INVESTIGATION OF SOIL AND GROUND-WATER CONTAMINATION AT THE U.S. ARMY PETROLEUM TRAINING FACILITY, FORT LEE, VIRGINIA, SEPTEMBER-OCTOBER 1989.
Geological Survey, Richmond, VA. Water Resources Div.
W. G. Wright, and J. D. Powell.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-387, 1990. 28p, 9 fig, 9 tab, 12 ref.

Descriptors: *Groundwater pollution, *Military reservations, *Oil pollution, *Virginia, *Water pollution sources, Monitoring.

Fuel-oil constituents in the soil and groundwater at the Fort Lee Petroleum Training Facility near Petersburg, Virginia, were studied by the U.S. Geological Survey (USGS) in cooperation with the Department of Defense, U.S. Army. The study included installation of 25 groundwater monitoring wells and description of groundwater flow patterns of the shallow-aquifer system underlying the facility. Soil and groundwater samples were collected to determine the concentrations of fuel-oil constituents and to determine the potential for off-site migration of the constituents. Total petroleum hydrocarbon concentrations up to 18,400 mg/km were reported in soil samples. Concentrations of benzene in water from wells at the facility were up to 130 micrograms per liter (ug/L), and concentrations of ethylbenzene and xylene were up to 54 and 120 ug/L, respectively. Potential exists for off-site migration of the contaminants and migration of contaminants downward to deeper aquifers. Further investigations of these potential contamination-migration pathways are warranted. Risk identification at the Petroleum Training Facility cannot be properly addressed because the distribution of the fuel-oil constituents has not been fully characterized. Preliminary identification of risk, however is presented by an examination of toxicity data for the chemical constituents reported in the groundwater at the facility. Concentrations of constituents were compared to the maximum contaminant levels (MCLs) for drinking water established by the U.S. Environmental Protection Agency (USEPA). Concentrations of benzene in water from wells at the facility exceed the USEPA's 5 ug/L MCL by as much as 26 times. Sufficient data are not available to fully design the remedial-action plan for the facility; however, general responses to contamination of the type associated with the facility include no-action, monitoring, institutional controls, removal, and treatment. (USGS)
W91-04864

TRENDS AND COMPARISON OF WATER QUALITY AND BOTTOM MATERIAL OF NORTHEASTERN ARKANSAS STREAMS, 1974-85, AND EFFECTS OF PLANNED DIVERSIONS.
Geological Survey, Little Rock, AR. Water Resources Div.
J. C. Petersen.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4017, August 1990. 215p, 5 fig, 140 tab, 71 ref.

Descriptors: *Arkansas, *Water pollution sources, *Water quality, Diversion, Seasonal variation, Sediments, Statistics, Time series analysis.

Water quality of several rivers in Arkansas was compared using median values at individual water quality stations. Differences were detected in several properties, including common dissolved constituents, alkalinity, nutrients, fecal coliform bacteria, trace metals, pesticides, and sediment. In bottom material, organochlorine pesticides were detected much more frequently than organophosphorus pesticides and were higher in rivers with beds of fine-gradient particles. Time trends were examined using the Seasonal Kendall test. Trends in conductance, sodium adsorption ratio, chloride, phosphorus, and ammonia were usually not detectable. Sulfate concentrations were increasing at approximately one-half of the stations studied while fecal-coliform bacteria concentrations decreased at approximately one-half of the stations. The most potentially detrimental effects upon water quality resulting from surface water diversions were related to increases of common dissolved constituents. From available data, the largest of these increases would be caused by diversion from the Arkansas River. Potential effects not specifically examined include resuspension of bottom materials resulting from construction and operation of the diversion system. Use of some surface waters for artificial recharge of the alluvial aquifer may adversely affect the recharge systems or the aquifer. Possible effects include plugging of the injection well and the aquifer. (USGS)
W91-04867

DEGRADATION OF ATRAZINE IN SOIL THROUGH INDUCED PHOTOCATALYTIC PROCESSES.
Parma Univ. (Italy). Ist. di Chimica Fisica Applicata.
E. Pelizzetti, V. Carlin, V. Maurino, C. Minero, and M. Dolci.
Soil Science SOSCAK, Vol. 150, No. 2, p 523-526, 1990. 2 fig, 1 tab, 23 ref.

Descriptors: *Atrazine, *Chemical degradation, *Fate of pollutants, *Photolysis, *Soil contamination, *Trace metals, *Triazine herbicides, Catalysis, Herbicides, Oxides, Semiconductors, Soil chemistry, Solar radiation.

Photocatalytic degradation of atrazine, a s-triazine herbicide, was observed in the presence of semiconductor metal oxide particulates (titanium oxide, zinc oxide) suspended in aqueous solution under simulated sunlight irradiation. The half-life for the process is approximately 5 and 80 minutes for titanium oxide and zinc oxide, respectively (at an initial atrazine concentration of 25 mg/L with 0.5 g of semiconductor per L and with a photon flux of .00003 einstein/min, and over a cell cross section of 4 sq. cm). The weak catalytic activity of the soils (2 g/L) is dramatically increased by the addition of 0.5 g of the semiconductor per liter. Half lives are 10 to 40 minutes, depending on the nature of the soil. Small additions to soil of semiconductor oxides greatly increases the photodegradation rate of atrazine under simulated solar radiation. Photocatalytic processes may represent relevant degradation pathways for agrochemicals. These results suggest that degradation of compounds present in the soil may be possible with the addition of limited amounts of semiconductor oxides. (Brunone-PTT)
W91-04911

TRIANGULAR FINITE VOLUME APPROACH WITH HIGH-RESOLUTION UPWIND TERMS FOR THE SOLUTION OF GROUNDWATER TRANSPORT EQUATIONS.
California Univ., Los Angeles. Dept. of Civil Engineering.
M. Putti, W. W. G. Yeh, and W. A. Mulder.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2865-2880, December 1990. 16 fig, 2 tab, 20 ref. NSF Grant DMS 88-11863, Naval Research Grant N0014-86-K-0691.

Descriptors: *Groundwater movement, *Groundwater pollution, *Mathematical models, *Model studies, *Path of pollutants, *Solute transport, Contamination, Finite difference methods, Finite element method, Mathematical analysis, Statistical methods, Viscosity.

A finite volume approach for the solution of the contaminant transport equation in groundwater is developed by defining a triangular control volume over which the dependent variable of the governing equation is averaged. The solution combines flexibility in handling complex geometries intrinsic to finite element methods with the simplicity of finite difference techniques. High-resolution upwind schemes are employed for the discretization of the advective terms. The technique is based on the concept of monotone interpolation to ensure the monotonicity preserving property of the scheme, and on the exact solution of local Riemann problems at the interface between neighboring control volumes. In this way, numerical oscillations are completely avoided for a full range of cell Peclet numbers. Together with the discretization of the dispersive fluxes, an approximation is obtained that is locally first order, but globally of second-order accuracy. As compared to usual upwind schemes, much smaller amounts of numerical viscosity are introduced when sharp concentration fronts occur. A number of numerical tests show good agreement with analytical solutions. (Author's abstract)
W91-04915

DISSOLVED ORGANIC CARBON CYCLING IN FORESTED WATERSHEDS: A CARBON ISOTOPE APPROACH.
Waterloo Centre for Groundwater Research (Ontario).
For primary bibliographic entry see Field 2K.
W91-04924

HYDROLOGIC FLOW PATH DEFINITION AND PARTITIONING OF SPRING MELTWATER.
Laval Univ., Quebec. Lab. d'Hydrologie Forestiere.
C. P. Maule, and J. Stein.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2959-2970, December 1990. 7 fig, 3 tab, 31 ref, append. Inland Water Directorate of Environmental Canada, Quebec Region Contract KA-313-6-2115.

Descriptors: *Acid rain, *Acid rain effects, *Canada, *Hydrologic cycle, *Path of pollutants, *Snowmelt, Environmental tracers, Isotope studies, Isotopic tracers, Lake acidification, Stream acidification, Watersheds.

More than half of the annual acidic deposition to Canada's boreal forests is released during spring snowmelt. To evaluate the impact of this acidity upon the aquatic environment, the sources and hydrologic pathways must be defined. Two environmental tracers, oxygen-18 and silica, were used to meet this objective for spring snowmelt at Lac Laflamme. Stream water could be partitioned into four distinct waters based upon event and flow path; however, similar division for lake water was not possible due to inconsistencies between tracer contents in the lake water. In terms of the major source of acidity, snow meltwater, stream water had an average meltwater content of 70% while near-shore lake water ranged from greater than 70% at spring melt commencement to less than 45% at the end. These high amounts of meltwater represent a severe hazard for the potential occurrence of 'acid shock' of nearshore spawning grounds. (Author's abstract)
W91-04925

IDENTIFIABILITY OF CONCEPTUAL HYDROCHEMICAL MODELS.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
F. M. Kleissen, M. B. Beck, and H. S. Wheater.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2979-2992, December 1990. 9 fig, 2 tab, 46 ref.

Descriptors: *Acid rain, *Flow models, *Hydrologic models, *Model studies, *Parameter estimation, *Path of pollutants, *Water chemistry, Flow pattern, Identifiability, Steady state, Stochastic models, Tracer studies, Uncertainty, Watersheds.

Estimating a uniquely best set of values for the parameters of conceptual hydrological models has long been a problem of considerable concern. More recent interest in using these models to determine the flow paths of water passing through catchments experiencing acidification has sharpened the focus of such concern on the role of tracer observations in model and parameter identifiability. Working with relatively simple linear and nonlinear two-store models, the deterministic analysis involves merely algebraic manipulation of the model's steady state description. While this form of analysis is of limited applicability (even with the assistance of computer algebra), the availability of tracer observations enhances model identifiability in all the cases examined. More complex model structures, and the effects of model and observation uncertainty, can be explored within a stochastic framework based on filtering theory. The availability of two tracer signals does not necessarily improve identifiability beyond what is possible with just a single tracer measurement. A basis exists for the cross-referencing of identifiability results between the deterministic and stochastic frameworks. (Author's abstract)
W91-04927

GROUNDWATER AND WETLAND CONTRIBUTIONS TO STREAM ACIDIFICATION: AN ISOTOPIC ANALYSIS.
Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
C. Wels, R. J. Cornett, and B. D. LaZerte.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2993-3003, December 1990. 8 fig, 7 tab, 45 ref.

Descriptors: *Acid rain, *Acidification, *Geochemistry, *Groundwater, *Isotope studies, *Streams, *Water pollution sources, *Wetlands, Canada, Hydrogen ion concentration, Hydrographs, Precambrian Shield, Residence time, Runoff.

Stream water pH may be influenced by the flow paths and the residence time of water that contributes to streamflow, when these hydrologic factors interact with the biogeochemical processes that neutralize hydrogen ions in the catchment. Measures of the volumes of groundwater contributing to streamflow, the groundwater residence times, and the sources of stream water acidity found during spring runoff in three basins on the Canadian Shield are given. Isotopic hydrograph separations were used to estimate the relative contributions of groundwater to spring runoff. The contributions of old (premelt) groundwater to spring runoff were greater (60%) in a well-buffered, third-order basin than in a more acidic first-order basin (49%). Using a simple mixing model, a larger groundwater reservoir (420 mm unit depth) and longer residence time (162 days) were estimated in the third-order basin. The lowest stream pH (4.8) was observed in a second-order basin with a wetland that collects drainage from about 79% of the basin. In this basin, the principal source of hydrogen ions was the conifer-sphagnum wetland. The hypotheses that the pH of these streams was proportional to a fraction of streamflow contributed by groundwater or the residence time of water in a basin are rejected. More attention must be focused upon the source of acidity generated in wetlands, since these are ubiquitous in small basins. (Author's abstract)
W91-04928

5C. Effects Of Pollution

SUCCESSIVE APPEARANCE OF SUBFOSSIL PHYTOPLANKTON SPECIES IN HOLOCENE SEDIMENTS OF THE NORTHERN ADRIATIC AND ITS RELATION TO THE INCREASED EUTROPHICATION PRESSURE.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
For primary bibliographic entry see Field 2L.
W91-03983

GRANITE WEATHERING AND THE SENSITIVITY OF ALPINE LAKES TO ACID DEPOSITION.
For primary bibliographic entry see Field 2H.
W91-03998

INDIRECT EFFECTS OF AN OIL SPILL: REPRODUCTIVE FAILURE IN A POPULATION OF SOUTH POLAR SKUAS FOLLOWING THE 'BAHIA PARAISO' OIL SPILL IN ANTARCTICA.
California Univ., Irvine. Dept. of Ecology and Evolutionary Biology.
Z. A. Eppley, and M. A. Rubega.
Marine Ecology Progress Series MESEDT, Vol. 67, No. 1, p 1-6, September 20, 1990. 2 fig, 1 tab, 34 ref. NSF Grant DPP8716005.

Descriptors: *Animal physiology, *Antarctica, *Behavior, *Marine pollution, *Oil spills, *Population dynamics, *Reproductive failure, *Skuas, *Water birds, *Water pollution effects, Animal growth, Ecosystems, Fouling, Poisoning, Predation, Temporal distribution, Toxicity.

Oil spills may have diverse negative impacts on organisms, exerting direct effects (such as fouling or poisoning) or indirect effects (by influencing a species' predator or prey). A complete reproductive failure was reported in a population of seabirds as an indirect result of the 'Bahia Paraiso' oil spill near Palmer Station in Antarctica. Mortality among nestling South Polar skuas was highly compressed in time and coincident with the spill. Adults were observed to forage in oil slicks and became fouled, but there was no transfer of oil to eggs or chicks. Young showed no evidence of toxicity (low growth rates or hemorrhagic gastroenteritis) and adult mortality was minimal. Instances of parental neglect increased ten-fold after the spill and undefended chicks were attacked by neighboring skuas. Exposure to oil appeared to cause a short-term disruption of normal parental attendance behavior which exposed young to fatal interspecific aggression. This example emphasizes that behavior and ecological interactions play major roles in determining the effects of oil on species. While these factors may be understood post hoc, correctly predicting the effects of environmental perturbations on species is a formidable task. (Author's abstract)
W91-04001

CONTINUING IMPORTANCE OF NITRATE CONTAMINATION OF GROUNDWATER AND WELLS IN RURAL AREAS.
Colorado Dept. of Health, Denver. Disease Control and Epidemiology Div.
For primary bibliographic entry see Field 5B.
W91-04003

CALIFORNIA'S PROPOSITION 65: EXTRAPOLATING ANIMAL TOXICITY TO HUMANS.
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 6E.
W91-04008

PERSISTENT POLLUTANTS IN FISH-EATING SEA BIRDS--BIOACCUMULATION, METABOLISM, AND EFFECTS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
For primary bibliographic entry see Field 5B.
W91-04011

CYTOPATHOLOGICAL INVESTIGATIONS OF DIGESTIVE TRACT AND STORAGE CELLS IN DAPHNIA MAGNA EXPOSED TO CADMIUM AND TRIBUTYLTIN.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
C. W. M. Bodar, E. G. van Donselaar, and H. J. Herwig.
Aquatic Toxicology AQTODG, Vol. 17, No. 4, p 325-338, October 1990. 8 fig, 1 tab, 33 ref.

Descriptors: *Animal pathology, *Antifoulants, *Cadmium, *Cytology, *Digestion, *Organotin compounds, *Tributyltin, *Water pollution effects, *Waterfleas, Aquatic animals, Behavior, Food collection, Glycogen, Histology, Metabolism, Reproduction, Ultrastructure.

Histopathological effects on the ultrastructural organization of digestive tract and storage cells of Daphnia magna were examined after a 7-day exposure to cadmium or tributyltin chloride. No distinct cytological changes were noted in the tissues of Daphnia magna exposed to 10 microg cadmium/L. In animals exposed to 20 microg cadmium/L, however, there was a slight decline in the glycogen content of the storage cells and some structural changes in the mitochondria of these cells. By contrast, in daphnids exposed to 1 or 5 microg tributyltin chloride/L the ultrastructural integrity of storage cells appeared to be seriously affected. In addition, conspicuous lipid accumulations were observed in posterior gut epithelium and in a specific hemolymphatic cell-type of tributyltin chloride-exposed Daphnia magna. The results reflect functional impairments in swimming behavior, food collecting apparatus, and storage cells. Previous studies have noted impairments in reproductive output, but no conclusive explanation can be given, other than a reduction of available resources in relation with an impaired food uptake. (Author's abstract)
W91-04012

ECDYSTEROIDS IN DAPHNIA MAGNA: THEIR ROLE IN MOULTING AND REPRODUCTION AND THEIR LEVELS UPON EXPOSURE TO CADMIUM.
Utrecht Rijksuniversiteit (Netherlands). Research Group for Aquatic Toxicology.
C. W. M. Bodar, P. A. Voogt, and D. I. Zandee.
Aquatic Toxicology AQTODG, Vol. 17, No. 4, p 339-350, October 1990. 5 fig, 1 tab, 24 ref.

Descriptors: *Cadmium, *Hormones, *Molting, *Reproduction, *Water pollution effects, *Waterfleas, Animal physiology, Ecdysteroids, Metabolism, Neonates, Toxicity.

The role of ecdysteroids in molting and reproduction of Daphnia magna was examined as to whether changes in the hormone levels could cause disturbances in these processes. Six concentrations of ecdysone and 20-hydroxyecdysone, ranging from .00000001 M to .000001 M, were administered to daphnids exogenously. Treatment with high concentrations of both ecdysteroids resulted in unsuccessful exuviations and a decline in the number of progeny per female. The size of the neonates, however, appeared to be unaffected. 20-Hydroxyecdysone was demonstrated to be more effective than ecdysone. The presence of ecdysteroids in whole-body extracts of adult females was demonstrated using an enzyme immunoassay. Additionally, ecdysteroid concentrations in daphnids were found to be affected by cadmium exposure at concentrations of 5.0, 10.0, and 20.0 microg/L. Changed ecdysteroid concentrations could have caused the molting impairments in cadmium-exposed daphnids. There was no indication that the endocrine response of Daphnia magna to cadmium exposure was also responsible for the cadmium-induced decline in neonate size. (Author's abstract)
W91-04013

EFFECT OF NAPHTHALENE ON SODIUM ACTIVE TRANSPORT IN THE FROG SKIN.
Oklahoma State Univ., Stillwater. Dept. of Zoology.
J. T. Blankenmeyer, and C. R. Hefler.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 627-632, November 1990. 3 fig, 7 ref.

Descriptors: *Animal physiology, *Naphthalenes, *Oil pollution, *Polycyclic aromatic hydrocarbons, *Sodium, *Water pollution effects, Active transport, Epidermis, Frogs, Ion transport, Toxicity.

Isolated abdominal frog skin, when mounted on an in vitro chamber actively transports sodium from the pond-side bathing solution to the serosal-side. Net transport of sodium is accomplished by the differential permeabilities of the pond-side membrane and the basolateral membrane, resulting in no net potassium transport and a measurable net sodium transport towards the basolateral side of the skin. Naphthalene, a polycyclic aromatic hydrocarbon, occurs in oil by-products and in crude oil. Naphthalene and similar compounds have been identified as acutely toxic petroleum products. Naphthalene has been shown to modify sodium/potassium ATPase of aquatic invertebrates and inhibit mitochondrial respiration. An initial 1 mg/L dose of naphthalene caused a drop in the internal skin circuit (ISC), and subsequent applications of naphthalene evinced more predictable responses. Naphthalene has an EC50 at 30 min after application of 4.4 mg/L, determined from eleven frogs. Naphthalene had no effect when administered to the blood side of the frog skin. The ISC increased corresponding to an increase in sodium transport. The mode of action in these experiments was probably on the entry of sodium into the cell. (Brunone-PTT)
W91-04015

TOXICITY OF NIGERIAN CRUDE OIL AND CHEMICAL DISPERSANTS TO BARBUS SP. AND CLARIAS SP.
Lagos Univ. (Nigeria). Toxicology Research Lab.
A. Akintonwa, and A. G. Ebere.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 729-733, November 1990. 2 tab, 10 ref.

Descriptors: *Dispersants, *Environmental impact, *Fish physiology, *Nigeria, *Oil, *Oil pollution, *Toxicity, *Toxicology, *Water pollution effects, Aquatic animals, Cleanup operations, Gills, Lethal limit, Oil spills, Risk assessment, Synergistic effects.

During an oil spill, contingency arrangements are made to limit environmental damage. One method is the use of chemical dispersants which break up the oil slick into oil and water emulsions. Some of these dispersants have been shown to cause damage to the respiratory epithelium of fish gills. In order to estimate the environmental impact of oil spillage and of chemicals used in cleanup operations, the toxicities of crude oil and chemical dispersants alone and in combination were investigated. Asabo 16c crude oil and the chemical dispersants Teepol and Conco-k were tested using fish of the genera Clarias and Barbus. The LC50 was estimated by graphical interpolation and an approximate nomographic method. The calculated crude oil LC50 was 21.5, 16.5, and 8.6 ml/L for 24, 48, and 96 hour test periods, respectively. Conco-k had LC50s of 11.5, 7.6, 5.7 ml/L and Teepol had LC50s of 7.8, 6.0, and 5.9 ml/L for the same test periods. Combinations of crude oil and oil dispersant were more toxic than each chemical alone. Therefore, the use of an oil dispersant in the event of an oil spill calls for caution and evaluation of the impact on the fauna in the area. (Brunone-PTT)
W91-04018

TOXICITY OF ETHYL-PARATHION AND CARBARYL ON EARLY DEVELOPMENT OF SEA URCHIN.
Universidad Nacional de Lujan (Argentina). Lab. of Ecotoxicology.
D. A. Hernandez, R. J. Lombardo, L. Ferrari, and M. C. Tortorelli.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 734-741, November 1990. 1 fig, 2 tab, 23 ref.

Descriptors: *Animal growth, *Carbamates, *Carbaryl, *Echinoderms, *Organophosphorus pesticides, *Parathion, *Pesticide toxicity, *Pesticides, *Toxicity, *Toxicology, *Water pollution effects, Acetylcholine, Agricultural chemicals, Animal pathology, Bioassay, Embryonic growth stage, Lethal limit, Marine pollution.

Organophosphates and carbamates are extensively used pesticides, both in agriculture and in domestic pest control. Increasing attention is being paid to their effects on non-target marine organisms. This study investigated the effects of two intensively used pesticides ethyl-parathion (DNTP) and carbaryl (CARB), on early developmental stages of the sea urchin Pseudechinus magellanicus, and attempted to improve laboratory manipulation of sea urchins to avoid developmental abnormalities which might interfere with the evaluation of toxic effects of xenobiotics. The effects of the pesticides on early development of the sea urchin were examined in the following stages: blastula, gastrula, prism and pluteus. Assay concentrations were 18, 32, 56, 100 and 180 microg/L for both pesticides. The pesticides were extremely toxic during early developmental stages, with EC50 values ranging from 157 microg/L to 2.8 microg/L. In DNTP, the EC50 values at the blastula and gastrula stages are similar, while at the prism stage the EC50 is significantly lower. This increase in DNTP toxicity could be attributed to a greater penetration and to the mode of action of the pesticide. DNTP produces an accumulation of acetylcholine, which impairs the development of sea urchin embryos by inhibition of cellular division and morphogenesis. In CARB, the developmental stages with active cleavage and cellular mobilization (blastula and gastrula) were more sensitive than the prism and pluteus stages. The decrease in toxicity after gastrulation could be attributed to an increase in detoxification processes by the cytochrome oxidase system. (Brunone-PTT)
W91-04019

EFFECT OF SUBLETHAL DOSES OF THREE PESTICIDES ON THE OVARY OF A CARP MINNOW RASBORA DANICONIUS.

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A. Rastogi, and S. K. Kulshrestha.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 742-747, November 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Carbofuran, *Endosulfan, *Fish pathology, *Minnow, *Parathion, *Pesticide toxicity, *Pesticides, *Sublethal effects, *Toxicology, *Water pollution effects, Disintegration, Fibrosis, Fish reproduction, Histology, Necrosis.

The contamination of water resources by pesticides may affect nontarget aquatic organisms including fish. Any change in the environment may adversely affect reproductive physiology. Comparative histopathological effects of three pesticides (carbofuran, endosulfan, and methyl parathion) were examined in the ovaries of a carp minnow Rasbora daniconius. Groups of about 50 fish were exposed to sublethal doses of 0.001 mg/L endosulfan, 0.1 mg/L carbofuran, and 0.1 mg/L methyl parathion for 75 days. T-tests were used to find statistical relationships between treated and control groups. The exposure of fish to endosulfan, carbofuran, and methyl parathion produced several deleterious effects: peritoneal linings were severely damaged on prolonged exposure to methyl parathion; necrosis and fibrosis in connective tissue was seen in all three treatments, as was dilation of blood vessels. Diameters of oocytes decreased with progressive duration of the exposure as compared with controls, and oocyte walls often ruptured. Cortical alveoli and yolk globules disintegrated in mature oocytes. (Brunone-PTT)
W91-04020

EFFECTS OF CHLORPYRIFOS ON THE KIDNEY OF FRESHWATER CATFISH, HETEROPNEUSTES FOSSILIS.

Gorakhpur Univ. (India). Dept. of Zoology.
S. K. Srivastava, P. R. Tiwari, and A. K. Srivastav.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 748-751, November 1990. 4 fig, 10 ref.

Descriptors: *Catfish, *Chlorpyrifos, *Insecticides, *Kidneys, *Pesticide toxicity, *Pesticides, *Toxicology, *Water pollution effects, Histology, Necrosis, Organophosphorus pesticides, Regulations, Sublethal effects.

Chlorpyrifos, a widely used multipurpose organophosphate insecticide, was tested on the kidney of a freshwater catfish, Heteropneustes fossilis. One group of 40 fish was exposed to chlorpyrifos at a concentration of 2 mg/L; another served as the control. No marked histological changes were noted up to 48 hours, but after 72 hours, the glomeruli are shrunken and the blood cells in glomerular tuft become vacuolated. After 96 hours, these changes are exaggerated and necrosis is seen. This necrosis has been noted in other fish after exposure to pollutants. (Brunone-PTT)
W91-04021

TOXICITY OF NICKEL AND NICKEL ELECTROPLATING WATER TO CHLORELLA PYRENOIDOSA.

Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
P. K. Wong, and C. K. Wong.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 752-759, November 1990. 7 fig, 2 tab, 20 ref.

Descriptors: *Chlorella, *Industrial wastewater, *Metal-finishing wastes, *Nickel, *Toxicity, *Toxicology, *Water pollution effects, Algal growth, Boric acid, Boron, Chlorophyta, Ecosystems, Electroplating, Heavy metals, Hong Kong, Path of pollutants, Trophic level.

Large amounts of heavy metals are discharged along with other toxic chemicals into industrial wastewater. The toxicities of nickel and other components in the nickel electroplating water on the growth of Chlorella pyrenoidosa, an important primary producer in small ponds in Hong Kong is investigated to evaluate the effects of nickel electroplating water on different trophic components of the food chains in small aquatic ecosystems. Five ml aliquots of algal cells from a late log phase culture were inoculated into solution containing 1, 2, 4, 8, 16, or 20 mg/L of nickel from electroplating water (EW), various concentrations of boric acid (0.1, 0.2, 0.4, 0.8, or 1.6 mg/L) and controls. Results indicate that growth rate was as sensitive as area under the growth curve for the detection of toxic effects of nickel to Chlorella pyrenoidosa. Toxicity of nickel was apparently higher in EW than in nickel sulfate (NS) or nickel chloride (NC). The presence of 4 mg/L of nickel from EW significantly inhibits the growth of the alga, while 4 mg/L from NS or NC showed no inhibitory effect on the algal growth. Higher inhibition of algal growth was observed in the presence of 0.4 mg/L or higher concentrations of boron ion. The presence of increasing concentrations of boron ion was the summation of the toxicity of boron ion and nickel ion. Individual or joint effects of individual components in electroplating wastewater should be determined in order to evaluate the hazard of electroplating wastewater to living organisms in the ecosystem. (Brunone-PTT)
W91-04022

EFFECT OF FLUORIDE ON ACETYLCHOLINESTERASE ACTIVITY AND OXYGEN CONSUMPTION IN A FRESHWATER FIELD CRAB, BARYTELPHUSA GUERINI.

Osmania Univ., Hyderabad (India). Dept. of Zoology.
S. L. N. Reddy, and N. B. R. K. Venugopal.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 760-766, November 1990. 2 tab, 20 ref.

Descriptors: *Acetylcholinesterase, *Animal metabolism, *Crabs, *Enzymes, *Fluorides, *Oxygen requirements, *Toxicology, *Water pollution effects, Adenosine triphosphate, Bioenergetics, Lethal limit, Path of pollutants, Respiration, Tissue analysis.

The toxic potential of sublethal concentrations of sodium fluoride on acetylcholinesterase (AchE) activity in various tissues and on time-course alterations in whole animal oxygen uptake in a freshwater field crab, Barytelphusa guerini were evaluated. To determine the LC50, animals were exposed to six serial concentrations of sodium fluoride. Leg muscle, hepatopancreas, heart, gill, and thoracic ganglion tissues were isolated after the experiment for analysis of AchE activity. Oxygen consumption of the crabs was measured and expressed as ml of oxygen per gram weight per hour. Students t-test was used to compare the differences between control and experimental groups. Oxygen consumption showed an initial increase, followed by a gradual respiratory rate depression over a prolonged exposure period. This result may occur because of the fluoride stress, and its effect on cellular energetics. AchE activity increased on the fourth day, also possibly attributable to fluoride stress. AchE activity was significantly inhibited in all tissues on the fifteenth day of exposure. The deviation in the response in the initial period needs further investigation on the availability of the ATP reserves as these are essential for maintaining neuronal activity. (Brunone-PTT)
W91-04023

CYTOLOGICAL ABNORMALITIES INDUCED BY MERCURY WATER POLLUTANTS ON ALLIUM CEPA L.

Burdwan Univ. (India). Dept. of Botany.
R. Pal, and S. Nandi.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 5, p 767-774, November 1990. 4 fig, 1 tab, 17 ref.

Descriptors: *Cytology, *Mercury, *Onions, *Plant pathology, *Toxicity, *Toxicology, *Water pollution effects, Biological magnification, Ecosystems, Food chains, Microscopy, Mitotic index, Photography.

Mercury presents potential hazards, even at low concentrations, due to enrichment in the food chain mainly through aquatic systems. A range of concentrations of mercury chloride, mercury dichloride and mercury oxide (.01 M, .001 M, .0001 M, .00001 M, and .000001 M) was selected for studying cytological effects on the primary root meristem of the onion, Allium cepa. Approximately 1000 cells from at least 6 meristems from 3 replicates were screened for mitotic indices. The mean percentages of aberrant cells were graphed and the aberrations documented with photomicrographs. After thirty minutes treatment, the mercury-treated tissues showed a much lower mitotic index than the controls, indicating that the chemicals were mitodepressant. When the treatment time was increased and the concentrations decreased, the mitotic index increased inversely. Among the different treatment times, the toxicity ranged from 30 minutes to 6 hours. All three mercuric compounds were clastogens and produced a high rate of chromosomal breakage. Various cytological abnormalities from these water pollutants produce deleterious effects on living cells. (Brunone-PTT)
W91-04024

EFFECTS OF SALINITY ON RIVER, STREAM AND WETLAND ECOSYSTEMS IN VICTORIA, AUSTRALIA.

Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.
B. T. Hart, P. Bailey, R. Edwards, K. Hortle, and K. James.

Water Research WATRAG, Vol. 24, No. 9, p 1103-1117, September 1990. 5 fig, 1 tab, 51 ref.

Descriptors: *Australia, *Saline groundwater, *Saline water control, *Salinity, *Water pollution effects, Ecosystems, Groundwater level, Invertebrates, Lakes, Macrophytes, Marsh plants, Streams, Water table decline, Wetlands.

Data on individual species were used to determine the possible adverse effects of saline wastewater discharges on aquatic ecosystems in Australia, in particular, lowland rivers and streams and wetlands. In these freshwater systems, the macroinver-

tebrates and plants (riparian vegetation, macrophytes, and micro-algae) were considered to be the most salt sensitive biological communities, with direct adverse biological effects likely to occur when salinity is increased to around 1000 mg/L. More subtle sub-lethal and indirect effects possibly occur at salinities below this level, however, the scientific data are not presently available to assess the extent that this might occur. To compensate for these uncertainties, detailed biological studies should be undertaken in all cases where salinity control measures are proposed that could lead to increased salinity in a receiving river, stream or wetland. These should include pre-release studies as well as post-release studies. Post-release studies should involve long-term biological monitoring of the system to ensure that subtle changes to the ecosystem are not occurring over an extended time period. (Geiger-PTT)
W91-04040

TRACE NUTRIENT DEFICIENCY IN DAPHNIA MAGNA CULTURED IN STANDARD MEDIUM FOR TOXICITY TESTING: EFFECTS OF THE OPTIMIZATION OF CULTURE CONDITIONS ON LIFE HISTORY PARAMETERS OF D. MAGNA.
Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.
For primary bibliographic entry see Field 5A.
W91-04047

INFLUENCE OF WATER COMPOSITION ON THE CHRONIC TOXICITY OF 3,4-DICHLOROANILINE TO DAPHNIA MAGNA.
Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.
B. P. Elendt.
Water Research WATRAG, Vol. 24, No. 9, p 1169-1172, September 1990. 2 tab, 15 ref. Federal Environmental Agency, Research and Development Project 106-03-072.

Descriptors: *Bioindicators, *Chlorinated hydrocarbons, *Chronic toxicity, *Daphnia, *Growth media, *Laboratory methods, *Water pollution effects, Culturing techniques, Testing procedures, Trace elements, Water analysis.

The influence of the composition of two synthetic media on the sensitivity of daphnia magna to 3,4-dichloroaniline (3,4-DCA) was tested in parallel. The two media differed in their content of trace elements. Medium M6 had only one-tenth of the trace element content of medium M4. The two media yielded similar results. The no observed effect concentrations (NOECs) for the reproduction of live neonates, the most sensitive indicator of toxicant stress, were 6 micrograms/L 3,4-DCA. The development of parthenogenetic eggs and embryos was affected by the toxicant at concentrations > or = 12 micrograms/L. It may be concluded that the trace element content of medium M4 does not exert a stress on Daphnia, which could in turn influence the toxicity of 3,4-DCA. The results are in line with earlier experiments using similar experimental conditions. This reflects a good reproducibility of results of chronic toxicity tests in a synthetic medium. (Author's abstract)
W91-04048

ELECTROPHILES AND ACUTE TOXICITY TO FISH.
Utrecht Rijksuniversiteit (Netherlands). Research Inst. of Toxicology.
J. L. M. Hermens.
Environmental Health Perspectives EVHPAZ, Vol. 87, p 219-225, July 1990. 4 tab, 32 ref.

Descriptors: *Acute toxicity, *Electrophilic compounds, *Fish, *Toxicology, *Water pollution effects, Chemical reactions, Hydrophobic compounds, Lethal limit, Physicochemical properties, Structure-activity relationships.

Effective concentrations in fish LC50 tests with directly-acting electrophiles are lower than those of unreactive chemicals that act by narcosis. LC50 values of more hydrophobic reactive chemicals tend to approach those of unreactive chemicals. Quantitative studies to correlate fish LC50 data to physical-chemical properties indicate that LC50 values of reactive chemicals depend on hydrophobicity as well as chemical reactivity. Direct electrophilic chemical reactions can be classified as acylation reactions, reactions with isocyanates, reactions with carbonyl compounds, alkylation and arylation of sulfhydryl (SH) groups, SH reactions with organometallic compounds and their derivative organic compounds, and other miscellaneous reactions with SH groups. This classification might be useful to identify chemicals that are more effective at lower concentrations than unreactive compounds. Chemicals that require bioactivation are not included because no information is available on the influence of bioactivation on acute toxic effects in aquatic organisms. (Fleishman-PTT)
W91-04059

EFFECTS OF HG(2+), CH3-HG(+), AND TEMPERATURE ON THE EXPRESSION OF MERCURY RESISTANCE GENES IN ENVIRONMENTAL BACTERIA.
California Univ., Irvine. Program in Social Ecology.
Y.-L. Tsai, and B. H. Olson.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3266-3272, November 1990. 5 fig, 2 tab, 35 ref. EPEI Grant 8000-25.

Descriptors: *Genetics, *Mercury, *Water pollution effects, Bacteria, Biochemistry, Enzymes, Heavy metals, Microbiological studies.

Mercury has received considerable attention because of its high toxicity and it has become an excellent model chemical for the study of biotransformation of metal salts. The complete detoxification of mercury involves the reduction of the form to the less toxic elemental mercury. Mercuric reductase, the enzyme encoded by the merA gene, is involved in the conversion of Hg(2+) to Hg(0), and the organomercurial lyase enzyme encoded by the merB gene is involved in the cleavage of H3C-Hg bond to release Hg(2+). Mercury resistant bacteria isolated from mercury-polluted sediments have been found to transform organic and inorganic mercury to Hg(0). Twenty different bacterial isolates obtained from a mercury-contaminated site in Oak Ridge, Tennessee, were grown on plate count agar amended with 25 microgram of Hg(2+) or 3 microgram of CH3-Hg(+) per ml. The total cellular RNA was extracted from each isolate by an acid-guanidine-thiocyanate-phenol-chloroform method. The transcripts of merA and merB were detected and quantitated by Northern RNA hybridization. A qualitative assay of mercuric reductase was used to confirm the enzyme activity. Low temperature (4 C) with the presence of Hg(2+) significantly increased the net merA transcripts of mid-log-phase cells of six environmental isolates. The net merA transcript production by 18 of the isolates increased when they were grown on 50% plate count broth with 25 microgram of Hg(2+) per ml, but only 8 isolates showed increased production of merB transcripts. The MICs of Hg(2+) and CH3-Hg(+) for 10 methyl mercury-resistant isolates ranged from 45 to 110 microgram of Hg(2+) and 0.6 to 4.5 microgram of CH3-Hg(+) per ml. CH3-Hg(+) was able to induce the expression of merB in 70% of methyl mercury-resistant strains. (Mertz-PTT)
W91-04062

DECREASED PERFORMANCE OF RAINBOW TROUT ONCORHYNCHUS MYKISS EMERGENCE BEHAVIORS FOLLOWING EMBRYONIC EXPOSURE TO BENZO(A)PYRENE.
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
G. K. Ostrander, J. J. Anderson, J. P. Fisher, M. L. Landolt, and R. M. Kocan.
Fishery Bulletin FSYBAY, Vol. 88, No. 3, p 551-555, 1990. 2 fig, 2 tab, 10 ref. U.S. EPA grant R-811348.

Descriptors: *Benz(a)pyrene, *Ecotoxicology, *Trout, *Water pollution effects, Aromatic compounds, Benzenes, Carcinogens, Ecological effects, Fish behavior, Hydrocarbons, Life history studies, Organic compounds, Sublethal effects, Toxicity, Water pollution.

One class of compounds, the aromatic hydrocarbons, has been implicated in carcinogenesis in feral fish populations. More subtle, yet profound, behavioral effects during early development may also result. Low levels of toxicants may affect important early life-history behaviors critical to survival. The sublethal effects induced by a model carcinogen and environmental contaminant on salmonid emergence behaviors were examined. Rainbow trout embryos were exposed for 24 hours to 25 microgram/mL of benzo(a)pyrene one week prior to hatching. Exposures occurred during the late organogenesis period of development and allowed assessment of how a single embryonic exposure might affect emergence behaviors nearly 6 weeks later. Though no differences in numbers of alevins successfully emerging were observed, a significant decrease was noted in performance of the upstream orientation behaviors characteristic of emergence among wild individuals. Emergence and orientation are activities that terminate a sequence of early-life behaviors critical for salmonid survival. These experiments indicated that fish exposed to benzo(a)pyrene had a greater chance of ending up in the downstream compartment. This could result if fish exposed to benzo(a)pyrene became fatigued faster or swam upstream slower. (Mertz-PTT)
W91-04069

STATUS OF THE FOURHORN SCULPIN, MYOXOCEPHALUS QUADRICORNIS, IN CANADA.
J. Houston.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 7-13, January/March 1990. 2 fig, 34 ref.

Descriptors: *Canada, *Fish populations, *Limiting factors, *Pesticides, *Sculpin, *Spatial distribution, *Water pollution effects, Alewife, Arctic zone, Chronic toxicity, Competition, Endangered species, Food chains, Mining wastes, Predation, Saline lakes, Species composition, Whitefish.

The Fourhorn Sculpin, Myoxocephalus quadricornis, is a widespread marine species, closely related to, and the probable progenitor of, the freshwater Deepwater sculpin, Myoxocephalus thompsoni. The species is widely distributed and abundant in the Canadian Arctic and is an important forage species for other fish and for waterfowl. Marine populations are secure but evolving isolates in euryhaline lakes of the Canadian Arctic Archipelago are probably vulnerable as these lakes are sensitive to perturbations. Saline lake populations may be susceptible to chronic trace contaminant exposure, pesticide exposure or to shifts in species composition. Bacteria important in the food chain of the Fourhorn Sculpin in Garrow Lake, Cornwallis Island, Northwest Territories are impacted by mining waste pumped from a nearby lead-zinc mine. The demise of the freshwater form, Myoxocephalus thompsoni, in Lake Ontario has been attributed to chronic pesticide and herbidcide pollution or recruitment failure as a result of predation or competition by Alewife. The Fourhorn Sculpin is also subject to intense predation in shallow water by gulls, waterfowl and shorebirds. The species is also eaten by whitefish, Arctic Char, eelpouts and other Cottidae including other members of its own species. (Geiger-PTT)
W91-04088

STATUS OF THE SPOONHEAD SCULPIN, COTTUS RICEI, IN CANADA.
J. Houston.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 14-19, January/March 1990. 2 fig, 21 ref.

Descriptors: *Canada, *Chronic toxicity, *Fish populations, *Limiting factors, *Population dynamics, *Sculpin, *Water pollution effects, Aquatic habitats, Endangered species, Lakes, Predation, Spatial distribution.

The Spoonhead Sculpin, Cottus ricei, is the most distinct North America member of the genus and on this continent is most closely related to the European Cottus gobei species group. The species is widespread east of the Great Divide ranging into Quebec and north to the mouth of the Mackenzie

River and other drainages into Hudson and James Bays. It has been recorded from all of the Great Lakes, but may be declining in Lake Erie and declining or extirpated from Lake Ontario. Elsewhere, the species is common where found and collection efforts in the 1970s have filled in many information gaps on the distribution in Ontario and Quebec. The distribution of the species appears to be closely related to glacial lakes created at the end of the Wisconsin period of glaciation. Postglacial dispersion of the species may still be occurring as drainage systems adjust to isostatic rebound. The species may be susceptible to chronic trace contaminant exposure, or to shifts in species composition in the deepwater community, as indicated for the Deepwater Sculpin, but this remains to be shown. Habitat changes and degradation due to silting may be limiting distribution in southwestern Ontario. (Geiger-PTT)
W91-04089

STATUS OF THE BLACKLINE PRICKLEBACK, ACANTHOLUMPENUS MACKAYI, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04090

STATUS OF THE BROOK SILVERSIDE, LABIDESTHES SICCULUS, IN CANADA.
C. D. Goodchild.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 36-44, January/March 1990. 4 fig, 42 ref.

Descriptors: *Canada, *Fish populations, *Limiting factors, *Population dynamics, *Silverside, *Turbidity, *Urbanization, *Water pollution effects, Aquatic habitats, Competition, Predation, Spatial distribution, Temperature effects.

The Brook Silverside, Labidesthes sicculus, is confined to a small region in south-central Canada. Populations of Brook Silverside are contiguous with those in the United States, but are at the northern limit of the species range. Although there have been no population studies, collection records do not indicate any evidence of a decline. Populations appear to be relatively stable and could be expanding slightly. Somewhat tolerant of alterations in habitat, it is extremely sensitive to turbidity and interspecific competition. This coupled with its one-year life cycle has the potential of completely decimating populations in a very short time span. Regular monitoring of this species should be encouraged. L. sicculus is particularly susceptible to increased turbidity, a condition which has become more widespread in southern Ontario as a result of urbanization, construction and agricultural activities. It disappears from waters that become turbid perhaps as a result of an inability to feed. Competition with other atherinids also limits the ability of L. sicculus to feed. Predation by other species may be a limiting factor for Brook Silverside because they are common forage for many species. Extremes in water temperature during winter (< 7 C) could eliminate an entire population of L. sicculus from an area. (Geiger-PTT)
W91-04091

STATUS OF THE BANDED KILLIFISH, FUNDULUS DIAPHANUS, IN CANADA.
J. Houston.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 45-52, January/March 1990. 3 fig, 41 ref.

Descriptors: *Canada, *Fish populations, *Killifish, *Limiting factors, *Pesticides, *Population dynamics, *Water pollution effects, Aquatic habitats, Competition, Hudson River, Predation, Spatial distribution.

The Banded Killifish, Fundulus diaphanus, is one of three species of the genus occurring in Canadian waters and is a species preferring the quiet waters of lakes and ponds. It tolerates temperatures in excess of 30 C, but prefers temperatures in the range of 21 to 28 C. They are often used by anglers as bait and can survive in water with low oxygen content for extended periods of time. In Canada, the Banded Killifish is widely distributed in the Maritime Provinces but is known from only a few localities in Newfoundland. The range extends west through southern Quebec and Ontario in the Great Lakes watershed to Lake Huron. Banded Killifish have been recorded from the Red River at Winnipeg, Manitoba, Crowduck Lake, Manitoba and Lake of the Woods, Ontario. The species has an extremely limited distribution in Newfoundland and Manitoba where further immigration in these areas is unlikely due to lack of suitable habitat or barriers to dispersion. Chronic exposure to aquatic contaminants such as pesticides may produce physiological symptoms and death of fish. Experiments carried out with Banded Killifish from the Hudson River indicate that there were no substantial effects to the species from chronic exposure to chlorinated hydrocarbons or organic phosphates at levels present in the river water. (Geiger-PTT)
W91-04092

STATUS OF THE LEAST DARTER, ETHEOSTOMA MICROPERCA, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04093

STATUS OF THE RIVER DARTER, PERCINA SHUMARDI, IN CANADA.
K. W. Dalton.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 59-63, January/March 1990. 3 fig, 11 ref.

Descriptors: *Canada, *Darters, *Endangered species, *Fish populations, *Limiting factors, *Population dynamics, *Urbanization, *Water pollution effects, Aquatic habitats, Channeling, Dredging, Spatial distribution, Turbidity.

The River Darter, Percina shumardi, is a small percid of larger streams, rivers, and some inland lakes of Manitoba and northwestern Ontario, in Canada, as well as in the United States. The species is also known from the Lake St. Clair drainage of southwestern Ontario. Very little is known of the biology or ecology of the species in Canada and it does not seem to be abundant anywhere, although populations appear to be stable. The River Darter is believed to be limited to large streams and lakes and is more tolerant of turbidity than other darters. It even seems to prefer shallow water in turbid locations. Pollution does not appear to be a major limiting factor in the western Canadian range of River Darters, but could be limiting in southwestern Ontario. Pollution in Illinois reportedly killed River Darters. Impoundments, dredging and channelization have led to the extirpation of the fish from some American rivers. (Geiger-PTT)
W91-04094

STATUS OF THE REDBREAST SUNFISH, LEPOMIS AURITUS, IN CANADA.
J. Houston.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 64-68, January/March 1990. 2 fig, 1 tab, 13 ref.

Descriptors: *Canada, *Endangered species, *Limiting factors, *Population dynamics, *Sunfish, *Water pollution effects, Agricultural runoff, Aquatic habitats, Fish populations, Industrial wastes, Pesticides, Pulp and paper industry, Spatial distribution.

The Redbreast Sunfish, Lepomis auritus, is one of the smaller centrarchids. The native range is confined to the Atlantic drainage east of the Appalachians. In Canada, the species is found only in New Brunswick where it has a restricted distribution. It is often overlooked because of its small size and its similarity to smaller members of other centrarchid species. No reliable information of the effects of aquatic contaminants on the species in the New Brunswick range is available, but these waters are subject to chemical pollution from industry (particularly the pulp and paper industry), agricultural runoff, urban wastes and pesticides (silviculture insect control programs). Due to the restricted range of the species and the potential risk of contamination in the watersheds where the species exists, the Redbreast sunfish should be considered vulnerable in Canada. (Author's abstract)
W91-04095

STATUS OF THE ORANGESPOTTED SUNFISH, LEPOMIS HUMILIS, IN CANADA.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
D. B. Noltie.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 69-86, January/March 1990. 3 fig, 2 tab, 177 ref.

Descriptors: *Canada, *Endangered species, *Limiting factors, *Population dynamics, *Sunfish, *Water pollution effects, Aquatic habitats, Competition, Fish populations, Heavy metals, Industrial wastewater, Oil pollution, Predation, Spatial distribution.

The Orangespotted Sunfish, Lepomis humilis, has only recently been described as a member of the fish fauna of Canada. Its known range in Canada is restricted to only three locations in southwestern Ontario. Population estimates and trends have not been established, but prospects for the species long-term establishment in Ontario appear good given trends in southern populations. The species' habitat in Ontario is primarily low-gradient, slow-flowing streams having turbid waters, silt, clay or mud bottoms, and minimal submerged aquatic vegetation, a feature shared with more southerly populations. The changing face of southwestern Ontario stream habitats has favored their invasion, and continuing agricultural impact bodes well for the numerical and geographical increase of the species in Canada. At present, the species is subject to no specific protection, but given the great beauty of L. humilis among Canadian fishes, a designation of vulnerable is suggested given its low numbers and extremely limited distribution. Small numbers of larger Orangespotted Sunfish are taken by anglers as panfish. Its numbers may also be limited by competition with other small native centrarchids and predation by other species. The species tolerance of oil refinery wastewaters is considered good, but many fractions of oil refinery wastes are considered lethal to Orangespotted Sunfish, especially smaller individuals. Zinc and cadmium concentrations in a small sample of L. humilis were high relative to a variety of species examined, suggesting that the accumulation of environmental contaminants might limit population numbers. Individuals also accumulated organochlorines, heavy metals, and other elemental contaminants. (Geiger-PTT)
W91-04096

STATUS OF THE BIGMOUTH BUFFALO, ICTIOBUS CYPRINELLUS, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04097

STATUS OF THE BLACK BUFFALO, ICTIOBUS NIGER, IN CANADA.
J. Houston.
Canadian Field-Naturalist CAFNAK, Vol. 104, No. 1, p 98-102, January/March 1990. 3 fig, 11 ref.

Descriptors: *Buffalo fish, *Fish populations, *Limiting factors, *Population dynamics, *Water pollution effects, Aquatic habitats, Canada, Dam effects, Endangered species, Lake Erie, Spatial distribution, Turbidity.

The Black Buffalo, Ictiobus niger, has only recently been reported from Canadian waters in the western end of Lake Erie. One earlier United States record for western Lake Erie is also known. The species is less common than the other buffalo fish and appears to have declined or been extirpated in portions of its United States range, but has extended its range elsewhere through introductions. The lower Great Lakes appear to be within the native range. The species is rare in Canadian waters. No specific limiting factors have been indicated, except that the Black Buffalo is intolerant of pollution. Ictiobus niger seems less tolerant of turbidity than the Smallmouth Buffalo, and may be limited by availability of suitable habitat and by damming of rivers for hydroelectric developments. It does adapt to life in impoundments, and could be utilized as a source of protein. Black Buffalo may

also be limited by competition with Carp. (Geiger-PTT)
W91-04098

STATUS OF THE GOLDEN REDHORSE, MOXOSTOMA ERYTHRURUM, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04099

SET MEMBERSHIP APPROACH TO IDENTIFICATION AND PREDICTION OF LAKE EUTROPHICATION.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Chemical Engineering.
K. Keesman, and G. van Straten.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2643-2652, November 1990. 7 fig, 2 tab, 25 ref, append.

Descriptors: *Ecosystems, *Eutrophic lakes, *Eutrophication, *Mathematical models, *Model studies, *Water pollution effects, Algal growth, Data interpretation, Mathematical studies, Theoretical studies.

Generally, ecosystems modeling is obstructed by the problem of sparse and unreliable data, and lack of knowledge about processes dominating the system. Under these circumstances, set theoretic uncertainty models are an appropriate alternative to probabilistic models. The only requirement is that the uncertainty is pointwise bounded. A newly developed set membership identification procedure is demonstrated by an application to the modeling of shallow lake eutrophication. First, a set of parameter vectors is identified. Analysis of the set reveals a dominant direction spanned by four algal growth and death parameters. Second, on the basis of additional fuzzy set theoretic assumptions, a formal min-max estimation is performed to obtain information about the model validity. If the model appears to be (partially) invalid, the degree of invalidity, affecting the model prediction uncertainty, can be represented by an estimate of the model structure error in addition to the uncertainty contained in the identified set of parameter vectors. (Author's abstract)
W91-04119

ARE LABORATORY-DERIVED TOXICITY DATA FOR FRESHWATER ALGAE WORTH THE EFFORT.
Battelle, Columbus, OH. Environmental Biology and Assessment.
M. A. Lewis.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1279-1284, 1990. 2 tab, 50 ref.

Descriptors: *Algae, *Environmental protection, *Toxicity, *Toxicology, *Water pollution effects, *Water quality monitoring, Chemicals, Effluents, Environmental impact, Hazard assessment, Laboratory methods, Literature review.

Algal toxicity test results are increasingly being considered in the evaluation of the environmental safety of chemicals and effluents. The ability of the current standard toxicity test methods to provide data useful in the safety assessment process was reviewed. It was concluded that there are too few data supporting the environmental relevance of those results derived using the standard methods in their present format. The current algal toxicity data base shows that interspecific variation in response to chemicals is significant and that field validation of most laboratory-derived results is lacking. Therefore, multiple test species should be used in algal toxicity tests and the biological significance of the recommended end points, including stimulation, needs definition before the results can be expanded to natural algal communities and be useful in predicting environmental impact. (Author's abstract)
W91-04146

AQUATIC TOXICITY TESTING USING THE NEMATODE, CAENORHABDITIS ELEGANS.
Georgia Inst. of Tech., Atlanta. School of Applied Biology.
P. L. Williams, and D. B. Dusenbery.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1285-1290, 1990. 3 tab, 37 ref. NIOSH Grant SOH (AHR) 1 R03 0H02095.

Descriptors: *Bioassay, *Environmental protection, *Nematodes, *Toxicity, *Toxicology, *Water pollution effects, *Water quality monitoring, Elements, Hazard assessment, Invertebrates, Laboratory methods, Lethal limit, Metals, Test species.

An aquatic toxicity test has been developed using a species of free-living nematode, Caenorhabditis elegans. The testing was performed with soluble forms of Ag, Hg, Cu, Be, Al, Pb, Cr, As, Tl, Zn, Cd, Ni, Sr, and Sb. The LC50 values for 1 and 4 d of exposure were determined and compared to the published invertebrate data. With C. elegans Pb, Cr and Cd were found to have the lowest 96-h LC50 (0.06 mg/L) and Sr had the highest LC50 (465 mg/L). All the metals except As have a significantly lower 96-hr LC50 (from 20 to 15,000 times lower) than 24-h LC50. Comparison with published data for other invertebrates indicated that C. elegans was more sensitive to Pb, Cr, and Be and less sensitive to As than any of the other organisms that have been tested. Given the ease in culturing and the extensive knowledge of the basic biology of C. elegans, coupled with the ecological abundance of nematodes, the method is worthy of further study to determine its usefulness as an aquatic test species. (Author's abstract)
W91-04147

ACUTE TOXICITY OF ISOMERS OF THE PYRETHROID INSECTICIDE DELTAMETHRIN AND ITS MAJOR DEGRADATION PRODUCTS TO DAPHNIA MAGNA.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
K. E. Day, and R. J. Maguire.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1297-1300, 1990. 1 tab, 15 ref.

Descriptors: *Acute toxicity, *Aquatic animals, *Insecticides, *Pyrethrins, *Toxicology, *Water pollution effects, *Waterfleas, Arthropods, Crustaceans, Degradation products, Deltamethrin, Isomers.

The acute toxicities (4-h, 24-h and 48-h) of eight stereoisomers and four major breakdown products of deltamethrin to Daphnia magna were determined. Parent deltamethrin (isomer 1) was the most toxic, with EC50 values in the range of 0.05 to 1.75 microg/L, concentrations that have been observed in the surface microlayer and subsurface water in field studies. The other three isomers (2-, 3-, and 4-deltamethrin) were two-fold to ten-fold less toxic than 1-deltamethrin. Isomers 1', 2', 3' and 4' plus the four breakdown products studied displayed no significant toxicity. 1-deltamethrin can be converted in natural water to 2'-, 3-, and 4'-deltamethrin. Because 3-deltamethrin is toxic to D. magna, this isomerization is only a partial detoxification step as far as some aquatic organisms are concerned. (Author's abstract)
W91-04149

REMOTE IN SITU APPARATUS FOR AMBIENT TOXICITY TESTING OF LARVAL AND YEARLING FISH IN RIVER OR ESTUARINE SYSTEMS.
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
M. C. Ziegenfuss, L. W. Hall, S. J. Bushong, J. A. Sullivan, and M. A. Unger.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1311-1315, 1990. 4 fig, 13 ref. U.S. Fish and Wildlife Service Cooperative Agreement No. 14-16-0009-87-924.

Descriptors: *Analytical methods, *Fish, *Pollutant identification, *Testing procedures, *Toxicity, *Toxicology, *Water pollution effects, Bass, Chesapeake Bay, Estuaries, Instrumentation, Potomac River, Rivers, Water quality monitoring.

A remote in situ apparatus for ambient toxicity testing of prolarval and yearling striped bass, Morone saxatilis, was designed and tested in the upper Chesapeake Bay and Potomac River during the 1989 spawning season. The apparatus was a catamaran design housing a continuous composite sampler which collected water samples for contaminants analysis. Prolarval and yearling testing chambers had loading capacities of 500 and 10 animals, respectively. Water quality parameters (temperature, pH, conductivity, salinity and dissolved oxygen) were measured at 1 h intervals. The range of prolarvae survival during three 96-h exposures at three Potomac River sites was 3-33%, whereas control survival was 83-92%. For three Upper Chesapeake Bay sites prolarvae survival was 6-52% versus 77-87% for controls. Low yearling survival (5-80%) at the end of 28-d in situ exposure was seen at three Potomac River sites. Conversely, high yearling survival (98-100%) was observed at three Upper Bay sites. Contaminants detected in composite samples from the Upper Chesapeake Bay included Cd (6.7 microg/L), Cr (19 microg/L), Cu (67 microg/L), and Pb (4.1 microg/L), as well as a number of insecticides. Composite samples from the Potomac River had maximum concentrations of 29 microg/L Cr and 12 microg/L As. It is concluded that the apparatus is suitable for ambient toxicity testing in river and estuarine environments. (MacKeen-PTT)
W91-04152

EFFECTS OF SELECTED PCB CONGENERS ON SURVIVAL, GROWTH, AND REPRODUCTION IN DAPHNIA MAGNA.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
T. M. Dillon, W. H. Benson, R. A. Stackhouse, and A. M. Crider.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1317-1326, 1990. 5 fig, 4 tab, 82 ref.

Descriptors: *Aquatic animals, *Bioindicators, *Polychlorinated biphenyls, *Toxicity, *Toxicology, *Water pollution effects, *Waterfleas, Animal growth, Biomass, Chronic toxicity, Congeners, Reproduction, Sublethal effects, Survival.

The effects of individual polychlorinated biphenyl (PCB) congeners on survival, growth and reproduction in the freshwater cladoceran, Daphnia magna, were determined. Congeners evaluated (IUPAC numbers 52, 77, 101, 118, 138, 153, 180) represent a variety of microsomal mixed-function oxidase (MFO) inducers. After 21 d of static renewal exposure, Daphnia survival was high (88-100%) in all congener treatments and unaffected by any PCB. Polychlorinated biphenyl congeners had little to no detectable sublethal effects on reproduction and growth. The number of neonates produced was either unaffected (congeners 52, 77, 118) or enhanced (congeners 101, 138, 153, 180). Effects on total biomass were mixed and the magnitude of significant differences, when observed, was small. Diminished biomass was observed in Daphnia exposed to congener 101 whereas increases occurred in treatments with congeners 52 and 118. Both elevated and diminished biomass was observed in animals exposed to congener 77. Congeners 138, 153 and 180 had no significant effect on Daphnia biomass. Daphnia accumulated substantial amounts of all PCBs even though minimal effects on survival, growth and reproduction were observed. Mean tissue concentrations ranged from approximately 2.0 to 130 ng/mg dry weight. These tissue residues are one to several orders of magnitude greater than those observed in fish and aquatic invertebrates collected in and around industrial waterways of the Great Lakes. Because the concept of PCB toxicity has been developed primarily through technical findings with mammals, caution should be exercised when applying those concepts to aquatic fish and invertebrates. (Author's abstract)
W91-04153

CLIMATE CHANGE AND CHANGES IN CALIFORNIA SNOWMELT-RUNOFF PATTERNS.
California State Dept. of Water Resources, Sacra-

mento. Div. of Flood Management.
For primary bibliographic entry see Field 2B.
W91-04215

BEHAVIOR OF DIAZINON IN A PERCH SPECIES.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Oekologische Chemie.
For primary bibliographic entry see Field 5B.
W91-04256

URBAN STORM-INDUCED DISCHARGE IMPACTS: US ENVIRONMENTAL PROTECTION AGENCY RESEARCH PROGRAM REVIEW.
Environmental Protection Agency, Edison, NJ. Storm and Combined Sewer Technology Branch.
R. Field, and R. E. Pitt.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 1-7, 1990. 26 ref.

Descriptors: *Environmental impact, *Storm water, *Urban hydrology, *Urban runoff, *Water pollution effects, Administrative agencies, Aquatic life, California, Deposition, Experimental design, Flow rates, Sediment transport, Storm sewers, Urban watersheds, Washington, Water chemistry, Water pollution sources.

The effects of storm-induced discharges on receiving water aquatic organisms or other beneficial uses is very site-specific. It is therefore necessary to carefully design comprehensive, long-term studies to investigate urban runoff problems on a site-specific basis. Sediment transport, deposition, chemistry, and aquatic biology play key roles in urban receiving waters and need additional research. Two West Coast studies sponsored by the Storm and Combined Sewer program of the U.S. Environmental Protection Agency both found significant aquatic life beneficial use impairments in urban creeks, but the possible causes were quite different. The Coyote Creek (San Jose, California) study found major accumulations of toxic sediments in the urban reaches of the creek, while the Bellevue (Washington) study found very little toxic material in the sediments. The Bellevue urban creek had a very large carrying capacity for sediment and high flow rates which apparently flushed the toxic sediments through the creek and into Lake Washington. Fish kills were observed in Bellevue, but they were associated with illegal storm drain discharges during dry weather. The long-term aquatic life effects of urban runoff are probably more important than short-term effects associated with specific events, and are probably related to the deposition and resuspension of toxic sediments, or the inability of the aquatic organisms to adjust to repeated exposures to high concentrations of toxic materials or high flow rates. Long-term effects may only be expressed at great distances downstream from discharge locations, or in accumulating areas (lakes). (Fish-PTT)
W91-04322

FURTHER RESEARCH NEEDS FOR IMPACT ESTIMATES OF URBAN STORM WATER POLLUTION.
Montpellier-2 Univ. (France). Lab. d'Hydrologie et de Modelisation.
M. Desbordes, and J. C. Hemain.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 9-14, 1990. 13 ref.

Descriptors: *Environmental impact, *France, *Research priorities, *Storm water, *Urban hydrology, *Urban runoff, *Water pollution effects, Sewer systems, Urban planning, Water pollution control, Water quality management, Water treatment facilities.

After some 15 years of research on urban runoff pollution characterization and modeling, it has become apparent that much more attention should be paid to storm water impacts upon receiving water bodies. Examination of the existing situation, based on the French experience of urban hydrological research, may help to re-examine some theoretical and experimental aspects for which a general agreement does not yet exist. Since the early 1960s, quality survey and restoration of receiving water bodies has been a constant objective for many French ministries, agencies, and institutions. One of the first of many actions was to control localized pollution sources from treatment plants; however, the actual pollution removal is not greater than 30% of the pollution load. Recent sewer network 'diagnosis' studies have clearly demonstrated the frequent incidences of sewers and small treatment plant failures in terms of the general pollution impacts on receiving waters. At the same time, studies related to urban runoff pollution have identified a considerable number of other pollution sources that have not been taken into account in the past when designing land use changes, sewer networks, and treatment plants. It appears that the urban water pollution problem must be attacked from an environmental point of view, as well as from scientific, technical, socioeconomical, and even educational and cultural aspects. The main elements that are encountered today in the study of urban pollution include: burden of existing sewer systems, reliability of urban pollution impact estimates, and gaps between field demands and researchers' actual knowledge. Consequently, a methodological approach needs to be developed to deal with the practical and the research levels of investigation. (Fish-PTT)
W91-04323

EVALUATION OF THE IMPACTS OF DISCHARGES FROM SURFACE WATER SEWER OUTFALLS.
Hydraulics Research Ltd., Wallingford (England).
J. A. Payne, and P. D. Hedges.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 127-135, 1990. 3 fig, 4 tab, 4 ref.

Descriptors: *Environmental impact, *Outfall sewers, *Storm water, *Urban runoff, *Wastewater disposal, *Water pollution effects, *Water pollution sources, Algae, Benthic fauna, Catchment areas, England, Impaired water quality, Land use, Macroinvertebrates, Metals, Sediment analysis, Water quality.

A broad-based approach has been used to assess the impacts of discharge to rivers from 47 surface water sewers in the U.K. to determine whether such discharges are damaging to stream quality. Three parameters were studied, all of which could reflect the effects of intermittent pollution on stream quality during dry weather: the numbers and types of benthic macroinvertebrates upstream and downstream of the outfalls, the concentrations of metals in algae upstream and downstream of the outfalls, and the concentrations of metals in sediments upstream and downstream of the outfalls. The field survey showed that discharges from surface water sewers have a measurable impact on receiving stream quality, which varies from site to site. The overall effect is a deterioration in water quality which can impair the use of the watercourse downstream of the outfall. Overall, there was a small but significant fall in biological quality. There was no detectable impact on the levels of metals in either sediment or algae samples taken upstream and downstream of the outfalls. Catchment characteristics influence impact and could be used to predict the likely impact of proposed outfalls from new developments. Catchment area and land use both influenced impacts at the study sites, with reductions in quality more likely to occur downstream of outfalls from large catchments, and the highest impacts at industrial and highway outfall sites. At least 28% of the sites studied had connections to the foul system, and a further 14% were observed to be discharging during dry weather. Most outfalls with sewage contamination were damaging to water quality. The quality of the receiving stream was an important factor in determining outfall impact. (Fish-PTT)
W91-04338

DISSOLVED OXYGEN STREAM MODEL FOR COMBINED SEWER OVERFLOWS.
Aalborg Universitetscenter (Denmark). Hydraulics and Coastal Engineering Lab.
K. Schaarup-Jensen, and T. Hvitved-Jacobsen.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 137-146, 1990. 7 fig, 10 ref.

Descriptors: *Combined sewer overflows, *Dissolved oxygen, *Model studies, *Storm water management, *Stream pollution, *Urban runoff, *Water pollution effects, Biodegradation, Comparison studies, Streeter-Phelps equation, Wastewater disposal, Wastewater facilities, Weather.

Dissolved oxygen (DO) depletion in receiving streams is a well-known impact of sewage disposal. Due to the fact that the concentration of degradable organic matter in combined sewage may be relatively high, it is not surprising that the potential effect of combined sewage overflows (CSOs) on the DO concentration of receiving streams may be harmful and often more important than the continuous discharges from, for example, wastewater treatment plants. During a CSO event a distinction between immediate and delayed DO consumption in the stream caused by biodegradation of soluble and particulate organics, respectively, is made. Two DO models have been developed in order to simulate the combined dry weather and wet weather effects. The first one is a simplified model based on the concept of an extended Streeter-Phelps equation and the second one is an advanced model, which is made from two integrated parts: a hydrodynamic and a transport-dispersion model. For the case of CSOs to a small stream with almost uniform flow, the simplified DO model results in DO concentrations comparable to similar results from the advanced DO model when the immediate oxygen consumption is neglected. It should be noted that the duration of computation will increase by a factor of about 1000 per CSO event, when choosing the advanced model instead of the simple model. However, it is important to stress that the advanced model is a valuable tool for simulating detailed phenomena related to a single event. Therefore, it can be concluded that the simple model, in the case of proper prerequisites, should be used for extreme event statistics while the advanced model should be chosen for single event analysis. (Fish-PTT)
W91-04339

URBAN STORM WATER DISCHARGES: EFFECTS UPON COMMUNITIES OF SESSILE DIATOMS AND MACRO-INVERTEBRATES.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
G. D. Willemsen, H. F. Gast, R. O. G. Franken, and J. G. M. Cuppen.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 147-154, 1990. 3 fig, 4 tab, 9 ref.

Descriptors: *Diatoms, *Environmental impact, *Macroinvertebrates, *Storm water, *Urban runoff, *Water pollution effects, Combined sewers, Ecosystems, Flow discharge, Industrial wastewater, Separated sewers, Species diversity, Storm-overflow sewers, The Netherlands.

From 1985 to 1987, long-term and more or less permanent effects of discharges from combined or separate sewer systems on communities of sessile diatoms and macroinvertebrates in receiving waters were studied at 46 locations throughout The Netherlands. The results were related to the type of sewer system, the discharges, and the characteristics of the receiving water, and compared with results from samples taken from a corresponding water not influenced by sewer overflows (the reference water). It was found that, in general, communities of sessile diatoms and macroinvertebrates indicate a more severe organic pollution and disturbance of receiving waters compared with reference waters. In the immediate vicinity of the overflows, these communities were more disturbed than at some distance. In small ditches, effects were more pronounced compared with large waterbodies and waters with a constant flow regime. Finally, effects of combined sewer overflows were more pronounced than effects of discharges from separate sewer systems, except for locations in industrial areas. (Author's abstract)
W91-04340

URBAN STORM WATER DISCHARGES: EFFECTS UPON PLANKTON COMMUNITIES.
Agricultural Univ., Wageningen (Netherlands).

Dept. of Nature Conservation.
H. F. Gast, R. E. M. Suykerbuyk, and R. M. M. Roijackers.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 155-162, 1990. 5 fig, 4 tab, 12 ref.

Descriptors: *Environmental impact, *Phytoplankton, *Storm water, *Urban runoff, *Water pollution effects, *Water pollution sources, *Zooplankton, Combined sewer overflows, Ecosystems, Flow discharge, Industrial wastewater, Separated sewers, The Netherlands, Water quality.

From 1985 to 1987, effects of sewer discharges on communities of phytoplankton and zooplankton in receiving waters were studied at locations throughout The Netherlands. The results were related to the type of sewer system, the discharges, and the characteristics of the receiving water, and were compared with those from samples taken from a corresponding water not influenced by sewer discharges (the reference water). It was found that often either phytoplankton or zooplankton communities could be used successfully to describe the short-term and medium-term effects of the discharges on the water quality of the involved habitats. Plankton communities could also indicate permanent effects due to higher saprobic levels in the receiving water compared to the reference water: an obvious result of urban storm water discharges. In small and medium-sized stagnant waters, particularly in the immediate vicinity of the overflows, effects on plankton communities were more pronounced compared to large and running waters. Combined sewer system overflows often proved to affect plankton communities more severely than separate sewer system discharges, except for some locations in industrial areas. (Author's abstract)
W91-04341

IMPACT OF STORM SEWAGE DISCHARGES ON THE ECOLOGY OF A SMALL URBAN RIVER.

Water Research Centre, Medmenham (England).
J. Seager, and R. G. Abrahams.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 163-171, 1990. 5 fig, 1 tab, 10 ref.

Descriptors: *Ecological effects, *Environmental impact, *Storm wastewater, *Storm water, *Urban hydrology, *Urban runoff, *Urban watersheds, *Wastewater disposal, *Water pollution effects, Benthic fauna, Bioassay, Combined sewer overflows, Ecosystems, England, Fish physiology, In situ tests, Macroinvertebrates, Oligochaetes, Species diversity, Toxins, Water pollution control, Water quality, Water quality standards.

Intermittent discharges of storm sewage from combined sewer overflows continue to be one of the principal causes of poor water quality in many urban rivers in the U.K. The study of how discharges of varying magnitude, duration, and frequency affect the ecological quality of receiving waters is of critical importance for deriving meaningful water quality criteria for the control of intermittent pollution. A study has been carried out on Pendle Water, a river which flows through the urban catchment of Burnley, Lancashire, England. In situ bioassays have been deployed to determine the impact of storm sewage discharges during heavy rainfall events on benthic invertebrate communities and physiological responses in fish. It was concluded that major storm events on Pendle Water result in significant reductions in the densities of certain benthic macroinvertebrate species. Results of experiments with caged invertebrates suggest that mortalities are high during such events. Discharges of storm sewage may exert a chronic effect on the benthos leading to alterations in community structure. Biological scores related to organic pollution and species diversity were both reduced downstream of combined sewer overflows and communities were characterized by large numbers of oligochaetes. In situ bioassays may be usefully deployed to examine biological responses to storm episodes of differing magnitude, duration, and frequency. These will provide information for the field validation of water quality criteria for intermittent pollution control derived from laboratory ecotoxicological data. (Fish-PTT)
W91-04342

DEVELOPMENT OF ECOTOXICOLOGICAL CRITERIA IN URBAN CATCHMENTS.

Middlesex Polytechnic, Enfield (England). Urban Pollution Research Center.
A. D. Bascombe, J. B. Ellis, D. M. Revitt, and R. B. E. Shutes.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 173-179, 1990. 4 fig, 2 tab, 10 ref.

Descriptors: *Environmental impact, *Storm water, *Toxicology, *Urban hydrology, *Urban runoff, *Urban watersheds, *Water pollution effects, *Water quality standards, Amphipods, Bioassay, Bioindicators, Copper, Ecosystems, In situ tests, Laboratory methods, Lead, Metals, Mortality, Toxicity, Zinc.

European environmental legislature is primarily based on a common toxicity analysis approach with ambient pollutant concentrations forming the basis for the development of water quality criteria. The method used to identify such standards for environmental protection is essentially based on fixed dose-response rates as determined from conventional laboratory bioassays. A biological assessment of the use of in situ indicator organism testing procedures has been made for the development of toxic criteria and a comparison of field experience with laboratory toxicity tests. Metal uptake and mortality rates were determined for selected body areas of the freshwater amphipod, Gammarus pulex, under both in situ stream and laboratory test conditions. Metal equilibrium concentration levels were achieved in soft tissue within five to six weeks exposure in the field with four-fold to five-fold increases over background control levels noted for saturation levels in caged organisms at sites subject to sewer discharges. Laboratory bioassays yielded short-term LC20 values in the order Pb>Cu>Zn, although there was little difference in metal toxicities over exposure periods of about one week. The controlled toxicity tests demonstrated a substantial short-term toxic enhancement over the in situ field bioassays. (Author's abstract)
W91-04343

IMPACT OF OVERFLOW ON SURFACE WATER QUALITY IN EAST BRABANT, THE NETHERLANDS.

East Brabant Dept. of Technology, Boxtel (Netherlands).
L. L. Bijlmakers, and R. A. M. Dierx.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 277-278, 1990. 2 tab, 3 ref.

Descriptors: *Combined sewer overflows, *Environmental impact, *Storm water, *The Netherlands, *Urban hydrology, *Urban runoff, *Water pollution effects, *Water pollution sources, Discharge capacity, Flow discharge, Water quality management, Water quality standards.

There are more than 900 overflow locations from the combined sewerage system in East Brabant, The Netherlands. The De Aa Water Board contains 220 overflow locations in its administrative area. Based on an occurrence of overflow in a standard rainshower of 60 L/s ha in dry weather conditions, the discharge capacity of the overflows according to the basic sewerage system plans of the municipalities, and an estimation of the water drainage of the receiving watercourses, two categories of watercourses can be distinguished. Category 1 comprises those watercourses which drain overflow water exclusively. The surface water quality at the overflow will be completely determined by overflow water. In Category 2 watercourses there will be some dilution, but the water quality will still essentially be controlled by the overflow water. In the De Aa area, 149 watercourses belong to one of these two categories. The Dungense Loop is classified as category 1, and, after an overflow in a dry weather period, dissolved oxygen, ammonium, and biochemical oxygen demand (BOD) did not meet the water quality standards. The River Dommel (Category 2) had relatively high concentrations of BOD, nitrogen, phosphates, and heavy metals after overflows. It can be concluded that overflows have a very negative effect on water quality. Consequently, the water quality standards in force will not be achieved. In order to meet these water quality standards it will be necessary to provide additional overflow structures, such as storage basins. (Fish-PTT)
W91-04356

SHORT-TERM TOXICITY OF NH3 AND LOW OXYGEN TO BENTHIC MACROINVERTEBRATES OF RUNNING WATERS AND CONCLUSIONS FOR WET WEATHER WATER POLLUTION CONTROL MEASURES.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
S. Gammeter, and A. Frutiger.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 291-296, 1990.4 fig, 1 tab, 6 ref.

Descriptors: *Benthic fauna, *Macroinvertebrates, *Oxygen depletion, *Storm water, *Toxicity, *Urban runoff, *Water pollution control, *Water pollution effects, Ammonia, Ecosystems, Fishkill, Mayflies, Oxygen balance, Stoneflies, Switzerland, Wastewater disposal.

The concentration of pollutants that can be washed out from the sewer system following the onset of rain can be high enough to cause a fishkill in the receiving river. The short-term toxicity of ammonia (NH_3) and low oxygen was determined for different species of aquatic insects (mayflies and stoneflies). The experiments were carried out in laboratory channels. Compared with fish species, the investigated macroinvertebrates were much less sensitive. Hence, if ecotoxicological criteria for the wet weather situation are developed for ammonia and oxygen, the requirements of sensitive fish species should be considered first. In Switzerland, exceedances of the NH_3 short-term threshold concentration caused by combined sewer overflow occur mostly in too-small receiving waters during summer thunderstorms. (Author's abstract)
W91-04360

CYTOLOGICAL STUDY OF VACUOLATED CELLS AND OTHER ABERRANT HEPATOCYTES IN WINTER FLOUNDER FROM BOSTON HARBOR.

Rhode Island Univ., Kingston. Coll. of Resource Development.
J. E. Bodammer, and R. A. Murchelano.
Cancer Research CNREA8, Vol. 50, No. 20, p 6744-6756, 1990. 26 fig, 66 ref.

Descriptors: *Boston Harbor, *Cytology, *Fish pathology, *Flounders, *Harbors, *Hepatocytes, *Liver, *Microscopic analysis, *Water pollution effects, Animal tissues, Marine fisheries, Mitochondria.

A light and electron microscopic study of hepatocytes in female winter flounder (Pseudopleuronectes americanus) from Boston Harbor has revealed 3 types of abnormal parenchymal cells in the livers of these fish. Electron-lucent or 'light' appearing hepatocytes had the following cytological features indicative of necrosis and cell death: an overall edematous (Hydropic) appearance; swollen nuclei with marginated chromatin; moderately swollen, dense mitochondria with flocculent densities; fragmented profiles of endoplasmic reticulum membranes; and lysosome-like bodies. Electron-dense or 'dark'-appearing hepatocytes were shrunken and irregular in shape, had a highly condensed cytoplasm, and had dense nuclei that frequently contained vacuoles. In addition, variably sized, organelle-containing fragments of these cells were infrequently observed in adjacent 'light' hepatocytes of histiocytes possibly resulting from apoptosis. Vacuolated hepatocytes arranged in ductular or acinar configurations demonstrated signs of chronic cell injury such as numerous autophagic vacuoles, condensed mitochondria, and a modified endoplasmic reticulum system, the dilated cisternae of which appeared to form the large vacuole of the cell. While experimental verification is lacking, it is presumed that the various hepatocyte alterations observed in the fish were induced

by environmental hepatotoxins. Further studies on the vacuolated cells and their possible relationship to neoplasia are warranted since a recent study found 15% (20) of winter founder samples from Boston Harbor with neoplastic lesions. (Author's abstract)
W91-04363

SUBCELLULAR LOCALIZATION OF ACID-RAIN TRANSPORTED ALUMINUM IN GILLS AND KIDNEYS OF TROUT FROM STREAMS OF THE VOSGES: PRELIMINARY RESULTS, (LOCALISATION SUBCELLULAIRE DE L'ALUMINIUM VEHICULE PAR LES PLUIES ACIDES DANS LES REINS ET BRANCHIES DE TRUITE DES VOSGES. DONNEES PRELIMINAIRES).
Clermont-Ferrand-1 Univ. (France). Faculte de Medecine et de Pharmacie.
For primary bibliographic entry see Field 5B.
W91-04364

WATERBORNE OUTBREAK OF LEPTOSPIROSIS AMONG UNITED STATES MILITARY PERSONNEL IN OKINAWA, JAPAN.
3rd Marine Division, FMFPAC, Okinawa, Japan.
For primary bibliographic entry see Field 5B.
W91-04365

WATER CONTACT AND SCHISTOSOMA HAEMATOBIUM INFECTION: A CASE STUDY FROM AN UPPER EGYPTIAN VILLAGE.
United States Medical Research Unit Number 3, Cairo, Egypt.
For primary bibliographic entry see Field 5B.
W91-04366

THERMOPHILIC CAMPYLOBACTERS IN SURFACE WATERS AROUND LANCASTER, UK: NEGATIVE CORRELATION WITH CAMPYLOBACTER INFECTIONS IN THE COMMUNITY.
Lancaster Univ. (England). Div. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W91-04369

EFFECT OF ZINC ON OSMOREGULATION OF GAMMARUS DUEBENI (CRUSTACEA: AMPHIPODS) FROM THE ESTUARY AND THE SEWAGE TREATMENT WORKS AT LOOE, CORNWALL.
Polytechnic South West, Plymouth (England). Dept. of Biological Sciences.
I. T. Johnson, and M. B. Jones.
Ophelia OPHLAN, Vol. 31, No. 3, p 187-196, 15 November 1990. 3 fig, 1 tab, 28 ref.

Descriptors: *Amphipods, *Estuaries, *Osmoregulation, *Toxicity, *Water pollution effects, *Zinc, Bioassay, Chronic toxicity, Comparison studies, England, Heavy metals, Population exposure, Sublethal effects, Tolerance, Water treatment facilities.

At Looe, Cornwall (South-west England), the euryhaline amphipod Gammarus duebeni Liljeborg has colonized the unique habitat of a sewage treatment works. The osmoregulatory capacity of Gammarus from the estuary and the sewage treatment works was compared. In unpolluted media, certain inter-populational differences in osmoregulatory and cuticle water permeability responses were identified; however, there were not consistent. Estuarine and 'sewage' Gammarus showed no hemolymph change when exposed to a range of external zinc concentrations at high salinity (30 ppt). Impairment of osmoregulatory capacity, relative to non-polluted levels, occurred at low salinity (10 ppt), but only at zinc concentrations > or = 500 micrograms Zn/L. For each population, depression of hemolymph osmolarity was apparently the result of reduced levels of blood sodium (and presumably chloride) rather than any zinc-induced charges in cuticle water permeability. These results are discussed with reference to previously identified evidence, from these populations, for enhanced zinc tolerance in sewage works gammarids as a result of long-term zinc exposure. It remains to be established whether the mortality which occurs during zinc exposure in low salinity is a direct consequence of decreased osmoregulatory capacity or is a secondary effect of metal toxicity. (Author's abstract)
W91-04376

EFFECTS OF ACID WASTES FROM TITANIUM DIOXIDE PRODUCTION ON BIOMASS AND SPECIES RICHNESS OF BENTHIC ALGAE.
Norsk Inst. for Vannforskning, Oslo.
T. Bokn.
Hydrobiologia HYDRB8, Vol. 204/5, p 197-303, September 28, 1990. 4 fig, 1 tab, 27 ref.

Descriptors: *Acidic water, *Algae, *Chemical wastes, *Estuarine environment, *Norway, *Toxicity, *Wastewater pollution, *Water pollution effects, Aquatic habitats, Bioassay, Diatoms, Fucus, Plant pathology, Titanium dioxide.

Titanium dioxide wastes are suspected to be toxic to rocky shore communities in an estuary in southeast Norway. An experimental project lasting 2 yr examined whether titanium dioxide wastes affected recolonization by rocky shore organisms. The experiments were performed in situ in six tanks (each with 9 cu m of brackish water) at two different levels of salinity. Three different concentrations of industrial waste water were used. The growth season of 1986 was dry and sunny compared to 1987, causing reduction of growth on exposed granite chips compared to controls. At the two highest waste concentrations in the tanks, Fucus serratus was observed with necrotic tissue both years, and in 1986 benthic diatoms were scarce. (Author's abstract)
W91-04420

ABUNDANCE CHANGES IN LAMINARIA SETCHELLII AND PTERYGOPHORA CALIFORNICA (LAMINARIALES, PHAEOPHYTA) NEAR THE DIABLO CANYON POWER PLANT.
California Inst. of Tech., Pasadena. W.M. Keck Engineering Lab. of Hydraulics and Water Resources.
W. J. North, E. K. Anderson, and F. A. Chapman.
Hydrobiologia HYDRB8, Vol. 204/5, p 233-239, September 28, 1990. 6 fig, 1 tab, 3 ref.

Descriptors: *Algae, *California, *Kelps, *Marine pollution, *Nuclear powerplants, *Thermal pollution, *Water pollution effects, Coastal waters, Diablo Canyon Power Plant, Mortality, Water depth, Water temperature.

Abundances of Laminaria setchellii and Pterygophora californica were determined three times per year for 2 yr before startup of the Diablo Canyon Power Plant (California) and thereafter for 3 yr during which time the plant was in operation. The test site was situated at 3 m depth and was exposed almost continuously to heated effluent during plant operation. A control population was established about 60 m away from the test site and at an 8 m depth (i.e., lying below the heated plume). Abundances at both sites are relatively stable during the preoperational period. Abundances of Laminaria and Pterygophora declined, mortality increased, and recruitment ceased at the test site following plant operation and the discharge of heated effluent. In contrast, Laminaria abundance remained stable at the control site and a strong recruitment episode markedly increased Pterygophora densities during 1987, the final year of our study. Complete losses of Laminaria and Pterygophora also were observed in nearby shallow portions of Diablo Cove exposed to the thermal plume. Laminaria was more sensitive to heated effluent than Pterygophora. Adults of both species were more sensitive than juveniles. (Author's abstract)
W91-04422

ECONOMICALLY IMPORTANT SEAWEEDS IN MAR PICCOLO, TARANTO (SOUTHERN ITALY): A SURVEY.
Istituto Sperimentale Talassografico 'Attilio Cerruti', Taranto (Italy).
E. Cecere.
Hydrobiologia HYDRB8, Vol. 204/5, p 281-286, September 28, 1990. 1 fig, 2 tab, 10 ref.

Descriptors: *Algae, *Italy, *Marine algae, *Marine pollution, *Wastewater pollution, *Water pollution effects, Aquaculture, Economic feasibility, Mar Piccolo Basin, Taranto, Wastewater treatment.

A preliminary survey was carried out of the marine algae in the Mar Piccolo Basin, Taranto (southern Italy), in order to assess the degree of sewage pollution and to determine the presence of any economically important species that might be productively utilized. The following commercial species, belonging to a drift algal community, were found: Gracilaria bursa-pastoris, G. cf. verrucosa, Solieria sp., and S. filiformis. The species showed an aggregated distribution within the community and a clear cyclic annual pattern. G. bursa-pastoris exhibited the highest mean biomass values in May, whereas Solieria spp. were most abundant in October. At present, only the harvesting of G. bursa-pastoris appears profitable. Further detailed studies are required to more fully assess the standing crop of the Solieria spp. and G. cf. verrucosa. Considering the environmental situation in the basin, it might be more appropriate to cultivate, rather than harvest, these commercially important seaweeds. With the large number of sewage outlet plants available in the basin, the cultivation of seaweeds in a wastewater treatment-aquaculture system should be considered. (Author's abstract)
W91-04423

TOXICITY OF SEWAGE-CONTAMINATED SEDIMENT CORES TO MACROCYSTIS PYRIFERA (LAMINARIALES, PHAEOPHYTA) GAMETOPHYTES DETERMINED BY DIGITAL IMAGE ANALYSIS.
California Inst. of Tech., Pasadena. W.M. Keck Engineering Lab. of Hydraulics and Water Resources.
D. E. James, J. K. Stull, and W. J. North.
Hydrobiologia HYDRB8, Vol. 204/5, p 483-489, September 28, 1990. 1 fig, 2 tab, 20 ref.

Descriptors: *California, *Kelps, *Marine pollution, *Sediment contamination, *Suspended sediments, *Toxicity, *Wastewater disposal, *Water pollution effects, Bioassay, Cadmium, Chromium, DDE, Digital image analysis, Heavy metals, Insecticides, Palos Verdes Peninsula, Plant pathology, Wastewater outfall, Zinc.

Macrocystsis pyrifera gametophytes were exposed in batch culture to varying mass concentrations of buried, sewage-contaminated, historically discharged sediment that had been sampled from two sites off Palos Verdes Peninsula, California. Significant gametophytic vegetative growth inhibition was detected in six days, using digital image analysis at sediment loadings ranging from 0.15 to 14.5 g in 500 mL nutrient-enriched seawater. Inhibition declined at low sediment loadings and increased at high loadings as cultures aged. Sediments corresponding to the historic emissions peak taken 2 km from the Joint Water Pollution Control Plant outfall inhibited vegetative growth more than did sediments sampled 13 km distant. Analysis showed elevated aqueous Cd(II), Cr(II), and p,p'-DDE concentrations in high sediment-loading culture medium. Inhibition by Zn(II) alone was observed at similar concentrations in other experiments, but synergism or antagonism by other toxicants remains possible. (Author's abstract)
W91-04424

RESULTS OF A TEN-YEAR STUDY (1976-1986) OF THE POPULATIONS IN SOFT SUBSTRATES OFF A WASTEWATER OUTFALL: MARSEILLE-CORTIOU. (LES ENSEIGNEMENTS D'UNE ETUDE SUR DIX ANS (1976-1986) DES PEUPLEMENTS DE SUBSTRATS MEUBLES AU LARGE D'UN EMISSAIRE D'EAUX USEES: MARSEILLE-CORTIOU).
Centre d'Oceanologie de Marseille (France).
G. Bellan, and M. Bourcier.
Cahiers de Biologie Marine CBIMA5, Vol. 31, No.

2, p 225-249, 1990. 5 fig, 5 tab, 28 ref. English summary.

Descriptors: *Aquatic organisms, *Ecosystems, *France, *Marseilles, *Outfall sewers, *Path of pollutants, *Species diversity, *Wastewater pollution, *Water pollution effects, Benthos, Interstitial water, Sediment chemistry, Statistical analysis, Succession.

Since the beginning of the sixties, benthic assemblages established on soft substrates have been studied in the vicinity in the Cortiou cove of the main sewer of the City of Marseilles. The noxious effects of the sewer are no longer considerable. In the seventies, a succession of catastrophic episodes linked with modifications in the nature and volume of discharged waters have resulted in the more or less marked disruption of the community structure in an area of more than 30 sq km. The physiological studies (and their relations with the chemistry of sediments and interstitial waters) were conducted in 1976. Among the 40 sampled stations, six were chosen for resampling in 1980 and 1986. During this period of ten years, a loss of species diversity took place. The population of the H3 station, the closest to the outfall, is distinct from the others. At the other stations, a progressive evolution from a 1976 state to a 1986 state with evidence of heavy degradation leading to the present community. These results are shown in statistical analyses, especially in correspondence factorial analysis. This research has contributed to the design of the large depurator plant of the City of Marseilles and to various subsequent processes to control the effects of pollution. (Author's abstract)
W91-04440

TOXICITY OF INORGANIC SELENIUM TO THE GREEN ALGA SELENASTRUM CAPRICORNUTUM PRINTZ.
Purdue Univ., Lafayette, IN. Dept. of Environmental Engineering.
A. M. Ibrahim, and A. Spacie.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 265-269, July 1990. 4 fig, 17 ref.

Descriptors: *Algal growth, *Chlorophyta, *Selenium, *Toxicity, *Trace metals, *Water pollution effects, Statistical analysis.

The selenate(VI) and selenite(IV) forms of selenium were found to be acutely toxic to the freshwater green alga Selenastrum capricornutum Printz. The concentrations causing 50% growth inhibition (EC50) in 24 hours were 61.5 mg Se/L for selenate and 143 mg Se/L for selenite. Subsequent EC50 values for selenite were 100 mg Se/L at 2 days; 96 mg Se/L at 4 days; and 65 mg Se/L at 6 days. Selenate was more toxic, producing 88% growth inhibition in 6 days at 40 mg Se/L compared to 18% for selenite at the same concentration. The relationship between growth inhibition and selenium concentration was found to be linear over the range of concentrations tested for both the selenate and selenite. Considering the interest in the environmental hazards of selenium, more chemical and toxicological studies for selenium should be performed under well-defined conditions. (Author's abstract)
W91-04448

EFFECT OF SIMULATED ACID RAIN ON REPRODUCTIVE ATTRIBUTES OF RED SPRUCE (PICEA RUBENS SARG).
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Forestry.
P. P. Feret, K. E. Diebel, and T. L. Sharik.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 309-312, July 1990. 1 tab, 21 ref.

Descriptors: *Acid rain, *Plant physiology, *Spruce trees, *Toxicity, Air pollution effects, Germination, Hydrogen ion concentration, Plant growth, Simulated rainfall, Water pollution effects.

Red spruce (Picea rubens) growth and reproduction is declining in many areas of the eastern United States. An often cited cause of this decline is air pollution. In this study, simulated acid rain was used to examine the effects of low pH on the female reproductive structures of five red spruce trees showing no signs of pollution damage. Cone scale weight, seed weight, number of seeds per cone, and per cent germination of filled seed did not differ significantly among the acid rain treatments. The percentage of filled seed per cone was significantly reduced as the pH of the simulated rain solutions declined. The results indicate that although acid rain may reduce successful fertilization, the number of seeds produced on healthy trees should be sufficient to ensure future generations of red spruce. Further studies comparing the reproduction of trees with visible foliar damage to healthy trees are needed to fully assess the problem. (Author's abstract)
W91-04449

RESPONSE OF GROWTH, PHOTOSYNTHESIS, AND MINERAL NUTRITION OF RED SPRUCE SEEDLINGS TO OZONE AND ACIDIC CLOUD DEPOSITION.
Tennessee Valley Authority, Muscle Shoals, AL.
F. C. Thornton, P. A. Pier, and C. McDuffie.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 313-323, July 1990. 2 fig, 6 tab, 31 ref.

Descriptors: *Acid rain effects, *Appalachian Mountains, *Cloud liquid water, *Nutrition, *Ozone, *Photosynthesis, *Plant growth, *Spruce trees, Biomass, Nitrogen, Respiration, Soil chemistry, Statistical analysis, Sulfur.

A field exclusion chamber study was established at a high elevation site in the Appalachian Mountains to determine the individual and combined effects of cloud water and ozone on the growth and physiological response of red spruce seedlings. Native seedlings from the study site, Whitetop Mountain, Virginia (1689 m), and seedlings grown from seed obtained from the Great Smoky Mountains in Tennessee were used in the study. Three replicates of the chamber treatments consisting of (1) exclusion of clouds and ozone, (2) exposure to ambient ozone with clouds removed, and (3) exposure to both ambient cloud and ozone were used in the study. Except for a statistically significant increase in current year needle biomass of native seedlings in treatments removing clouds or clouds and ozone, treatment effects were minimal. Periodic gas exchange measurements of seedlings taken throughout the growing season indicated that treatment-dependent effects on photosynthesis and respiration of both seedling types were few. Seedlings exposed to cloud moisture appeared to accumulate greater levels of nitrogen but not sulfur. Increased nutrient leaching of foliar ions was not consistently observed, and soil exchangeable cations did not differ among treatments. These data do not indicate treatment-induced changes in seedling growth that would serve as primary cause(s) in recently reported red spruce decline at high elevation. (Author's abstract)
W91-04450

FOLIAR RETENTION OF 15-N-NITRATE AND 15-N-AMMONIUM BY RED MAPLE (ACER RUBRUM) AND WHITE OAK (QUERCUS ALBA) LEAVES FROM SIMULATED RAIN.
Oak Ridge National Lab., TN. Environmental Sciences Div.
C. T. Garten, and P. J. Hanson.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 3, p 333-342, 1990. 2 fig, 3 tab, 14 ref.

Descriptors: *Acid rain effects, *Air pollution effects, *Ammonium, *Maple trees, *Nitrogen cycle, *Nutrients, *Oak trees, *Plant physiology, Forests, Hydrogen ion concentration, Nitrates, Nitrogen radioisotopes, Nutrition.

Studies of nitrogen cycling in forests indicate that trees assimilate atmospheric nitrate and ammonium and that differences between atmospheric deposition to the forest canopy and deposition measured in forest throughfall can be attributed to the removal of these ions from rain by tree leaves. Red maple and white oak leaves were exposed to artificial rain solutions (pH 4.1) containing nitrogen-15 labeled nitrate (3.5 microg N/ml) or ammonium (2.2 mg N/ml). At two time intervals after exposure (approximately 3 hr and 2 days) an exposed leaf and a control (non-exposed) leaf were removed from replicate seedlings. Based on results from nitrogen-15 analysis, most of the nitrate applied to tree leaves was removed by washing with water; the mean per cent removal (+/-standard error, N = 4) was 87 +/-1 and 73 +/-4% of the nitrogen-15 labeled nitrate applied to red maple and white oak leaves, respectively. Relative retention of nitrogen-15 labeled ammonium by the leaves was greater than that observed for nitrogen-15 labeled nitrate. In red maple and white oak leaves, 58 +/-9% and 84 +/-7% (mean +/-standard error, N = 4) respectively, of the applied ammonium was not removed by washing treatments. Results show that the foliar uptake of nitrogen-15 labeled ammonium from simulated rain by deciduous tree leaves is greater than that for nitrogen-15 labeled nitrate ions. Greater retention of ammonium ions than nitrate ions by red maple and white oak leaves from simulated rainfall is consistent with field observations showing a preferential retention of ammonium from rainfall by forest canopies. As nitrogen chemistry and the relative importance of nitrogen compounds in the atmosphere change in response to proposed emissions reductions (and possibly climate change), an improved understanding of the fate of airborne nitrogen compounds in forest biogeochemical cycles will be necessary. (Author's abstract)
W91-04452

HEALTH EFFECTS OF BEACH WATER POLLUTION IN HONG KONG.
Hong Kong Environmental Protection Dept.
W. H. S. Cheung, K. C. K. Chang, R. P. S. Hung, and J. W. L. Kleevens.
Epidemiology and Infection EPINEU, Vol. 105, No. 1, p 139-162, August 1990. 3 fig, 10 tab, 41 ref.

Descriptors: *Beaches, *Coastal waters, *Epidemiology, *Hong Kong, *Human diseases, *Path of pollutants, *Water pollution, Escherichia coli, Fecal coliforms, Microbiological studies.

Prospective epidemiological studies of beach water pollution were conducted in Hong Kong in the summers of 1986 and 1987. For the main study in 1987, a total of 18,741 usable responses were obtained from beachgoers on nine beaches at weekends. The study indicated the overall perceived symptom rates for gastrointestinal, ear, eye, skin, respiratory, fever, and total illness were significantly higher for swimmers than non-swimmers, and the swimming-associated symptom rate for gastrointestinal, skin, respiratory and total illness were higher at barely acceptable beaches than at relatively unpolluted ones. Escherichia coli was found to be the best indicator of the health effects associated with swimming-associated gastroenteritis and skin symptom rates when compared with other microbial indicators. A linear relationship between Escherichia coli and the combined symptom rates was established. Staphylococci were correlated with ear, respiratory and total illness, but could not be used for predicting swimming-associated health risks. They should be used to complement Escherichia coli. (Author's abstract)
W91-04454

FAECAL CONTAMINATION OF WATER AND FINGERTIP-RINSES AS A METHOD FOR EVALUATING THE EFFECT OF LOW-COST WATER SUPPLY AND SANITATION ACTIVITIES ON FAECO-ORAL DISEASE TRANSMISSION. II. A HYGIENE INTERVENTION STUDY IN RURAL NORTH-EAST THAILAND.
Leeds Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-04457

WATER RELATIONS OF DIFFERENTIALLY IRRIGATED COTTON EXPOSED TO OZONE.
California Univ., Riverside. Statewide Air Pollu-

tion Research Center.
For primary bibliographic entry see Field 3F.
W91-04505

INTENSE AND LOCALIZED BENTHIC MARINE POLLUTION AROUND MCMURDO STATION, ANTARCTICA.
Moss Landing Marine Labs., CA.
For primary bibliographic entry see Field 5B.
W91-04514

KELP RESPONSE FOLLOWING THE WORLD PRODIGY OIL SPILL.
Smith Coll., Northampton, MA. Dept. of Biological Sciences.
P. Peckol, S. C. Levings, and S. D. Garrity.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 473-476, 1990. 1 fig, 2 tab, 22 ref.

Descriptors: *Hydrocarbons, *Kelps, *Marine pollution, *Narragansett Bay, *Oil spills, *Rhode Island, *Water pollution, *Water pollution effects, Algal growth, Pigments, Plant physiology, Water depth.

Associated with the June 1989 grounding of the tanker World Prodigy on Brenton Reef, Rhode Island, approximately 922 tons of Number 2 fuel oil were released into surrounding coastal waters. Effects of oiling on the subtidal kelps Laminarina saccharina and L. digitata were investigated. Kelp condition, growth rates with depth, and pigment acclimation were compared with pre-spill measurements of kelp performance at the same site in 1984 to 1987. No evidence was found that kelps were detrimentally affected by oiling; no necrotic or bleached tissue on any kelps in an oiled cove were noted. Growth rates of both species were within the range of the previous years' data and pigment acclimation was similar for all years. Lowest growth rates occurred in 1985 during a severe brown tide. This study and other data suggest that Narragansett Bay was spared potential disaster because little fuel oil mixed into the water column and contacted subtidal organisms. (Author's abstract)
W91-04521

BENTHOS ON TAILINGS BEDS FROM AN ABANDONED COASTAL MINE.
Victoria Univ. (British Columbia). Dept. of Biology.
D. V. Ellis, and P. M. Hoover.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 10, p 477-480, 1990. 2 fig, 2 tab, 8 ref.

Descriptors: *Benthos, *Ecosystems, *Marine pollution, *Mine wastes, *Species diversity, *Water pollution effects, Aquatic animals, Canada, Howe Sound, Statistical analysis.

In the Howe Sound, on the west coast of Canada, the marine benthos which had recolonized the site of a mine tailings discharge 12 years after copper mining activity had ceased was compared to an adjacent area in which no tailings were found. Test (tailings) and Reference (no tailings) sampling stations consistently separated in a series of six cluster analyses. They invariably provided the last linkages, demonstrating that biological differences between tailing and non-tailing areas remain after 12 years. Tailing station faunas were less diverse than those at non-tailing stations, and each had characteristic faunas. Shallow (25 m) and deep (100 m) stations clustered together for both Test and Reference transects, but were significantly different ($P < 0.05$). A progressive increase in diversity existed from shallow to deep stations, and from tailings to no tailings, and different highly abundant species were found at each station. The pattern of clusters and their significance was not affected by reducing taxa for the analyses to only those fully identified to species. Screening specimens from deposits using 2 mm and 0.5 mm mesh sieves, gave paired data sets, which clustered together for each sampling station. Only in one case were these sieve clusters significantly different, suggesting that sieve mesh size in this investigation did not seriously influence the results. (Author's abstract)
W91-04522

DO ORGANIC AND ANTHROPOGENIC ACIDITY HAVE SIMILAR EFFECTS ON AQUATIC FAUNA.
Canterbury Univ., Christchurch (New Zealand). School of Forestry.
K. J. Collier, O. J. Bell, A. K. Graesser, M. R. Main, and M. J. Winterbourn.
OIKOS OIKSAA, Vol. 59, No. 1, p 33-38, September 1990. 3 tab, 59 ref.

Descriptors: *Acid rain effects, *Acid streams, *Acidic water, *Ecosystems, *Humic acids, *Hydrogen ion concentration, *New Zealand, *Stream biota, *Water pollution effects, Adaptation, Aluminum, Animal physiology, Aquatic insects, Evolution, Organic acids, Physicochemical properties, Tolerance, Toxicity.

In Westland, New Zealand, there are many brown-water streams with naturally low pH (often around 4) brought about by high concentrations of organic acids. Up to 90% of dissolved aluminum in these humic streams is bound to organic matter and is therefore non-toxic. This condition permitted the investigation of effects of long-term, natural acidity on aquatic biota without the compounding effects of high concentrations of toxic aluminum that are found in many anthropogenically-acidified, clear-water streams of the Northern Hemisphere. Most fish are absent from Northern Hemisphere clear-water habitats with pH < 5. However, in Westland, 9 out of 14 native fish species were found in brown waters with pH below 5, and seven species were taken from waters with pH < 4.5. Furthermore, 34 of the 37 most widespread aquatic insect taxa were recorded in Westland streams with pH < 5, and 24 were taken from sites with pH < 4.5. Clearly, many members of the freshwater fauna in Westland are well-adapted for life in waters of low pH. Physiological adaptations enabling this tolerance may be the same as those that evolved in response to the physicochemical variability associated with the unpredictable flow regimes of Westland streams. Tolerances of low pH have been documented in aquatic fauna from some naturally acidic, humic waters of the Northern Hemisphere, although degree of tolerance can vary within as well as between species. Colonization of recently-acidified waters by acid-tolerant strains may cause more subtle changes in community structure than can be detected by conventional ecological techniques. (Author's abstract)
W91-04528

SUBMERSED MACROPHYTE GROWTH AT LOW PH: I. CO2 ENRICHMENT EFFECTS WITH FERTILE SEDIMENT.
State Univ. of New York at Binghamton. Dept. of Biological Sciences.
J. E. Titus, R. S. Feldman, and D. Grise.
Oecologia OECOBX, Vol. 84, No. 3, p 307-313, October 1990. 3 fig, 3 tab, 27 ref. NSF Grant BSR 8506730.

Descriptors: *Acid rain effects, *Carbon dioxide, *Hydrogen ion concentration, *Nutrient concentrations, *Plant growth, *Plant physiology, *Submerged plants, *Water pollution effects, Acidic lakes, Aluminum, Nutrition, Sediment chemistry, Wild celery.

Vallisneria americana (wild celery) was grown for six weeks in a greenhouse on relatively fertile sediment to test for factors other than nutrient limitation which may slow growth of this submersed macrophyte at pH 5. On the basis of dry mass accumulated, (1) low pH significantly depressed Vallisneria growth at constant free carbon dioxide levels; (2) free carbon dioxide enrichment, however, greatly stimulated Vallisneria growth at pH 5, by 2.8-fold and 10-fold at 3.2 times and 10 times air-equilibrated carbon dioxide levels, respectively; and (3) growth was greater by far at pH 5 than at higher pH with constant total dissolved inorganic carbon (DIC). Free carbon dioxide availability was thus an important controller of growth at low pH by Vallisneria americana on fertile sediment, and low pH was not directly deleterious. Field surveys of acidic lakes in the Adirondack Mountains of New York State revealed that DIC levels in low pH lakes were often well above equilibrium values and could potentially support vigorous macrophyte growth. Aluminum and/or iron toxicity did not appear to impair growth at low pH, and aluminum concentrations in Vallisneria shoots significantly decreased with increasing free carbon dioxide concentrations at pH 5.0, perhaps due to growth dilution. Rosette production (a measure of asexual reproduction), maximum leaf length, and extent of flowering within treatments were positively correlated with plant biomass, rather than with pH or free carbon dioxide levels per se. (Author's abstract)
W91-04529

EFFECT OF SIMULATED ACIDIC FOG ON CARBOHYDRATE LEACHING, CO2 ASSIMILATION AND DEVELOPMENT OF DAMAGE SYMPTOMS IN YOUNG SPRUCE TREES (PICEA ABIES L. KARST).
Giessen Univ. (Germany, F.R.). Inst. of Plant Nutrition.
K. Mengel, M. T. Breininger, and H. J. Lutz.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 2, p 165-173, April 1990. 4 fig, 2 tab, 26 ref.

Descriptors: *Acid rain, *Acid rain effects, *Air pollution effects, *Artificial precipitation, *Fog, *Plant pathology, *Plant physiology, *Spruce trees, Carbohydrates, Carbon dioxide, Glucose, Leaching, Leaves, Photosynthesis, Plant growth, Roots, Starch, Stress.

Research in recent years on acid rain has shown that the acidity of fine droplets of fog is important. The effect of acidic fog on carbohydrate leaching, CO2 assimilation, carbohydrate status, and cuticle development of young spruce trees was studied in a greenhouse experiment. Over a period of 9 weeks the plants were subjected to fog application on 27 occasions. In one treatment trees were exposed to a fog of pH 5.00 (control treatment). Leaching rates for carbohydrates (sucrose, glucose, fructose) were significantly higher in the acidic fog treatment than in the control treatment. The total amount of carbohydrates leached out of the trees by acidic fog, however, was low and amounted to less than 1% of the nonstructural carbohydrates in the needles. Trees which had been exposed to acidic fog were not affected in photosynthesis and in the distribution of photosynthates to various plant parts. In the younger needles significantly lower concentrations of starch, glucose, and fructose were found in the treatment with acidic fog as compared with the control plants. Also the starch concentration in the roots of the control plant was significantly higher than that in the plants exposed to acidic fog. These findings are suggestive of a stress situation with a high energy demand. Application of acidic fog resulted in a disintegration of the epicuticular wax layer and of the epistomatal wax props. In the treatment with acidic fog some needles of the current year turned reddish-brown and some older needles became chlorotic and later brown. These needles were shed to a large degree. Needle loss of the trees exposed to acidic fog was significantly higher than that of the control trees. (Author's abstract)
W91-04560

DESIGN AND PERFORMANCE OF AN ACIDIC PRECIPITATION DELIVERY SYSTEM FOR FIELD INVESTIGATION WITH PLANTS.
Boyce Thompson Inst. for Plant Research, Ithaca, NY.
T. L. Lauver, J. A. Laurence, and R. J. Kohut.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 629-634, September/October, 1990. 4 fig, 2 tab, 22 ref. Electric Power Research Institute Contract RP2799-1.

Descriptors: *Acid rain, *Acid rain effects, *Air pollution effects, *Field tests, *Simulated rainfall, *Trees, Equipment design, Ozone, Spruce trees.

An acidic precipitation delivery system was designed and constructed for use in a field investigation of the response of red spruce saplings (Picea rubens Sarg.) to the interactive stresses of ozone

and acid rain. The system utilizes hydraulic, solid-cone spray nozzles to produce simulated rainfall with droplet size distributions approximating natural rain events, which are of low intensity, i.e., about 1-1.5 cm/hr, and are relatively uniform in distribution of volume over a 2.4 m diameter plot. Three different pH treatments (3.1, 4.1, 5.1) were dispensed randomly to each of three treatment subplots located in twelve open-top field chambers and three ambient control chambers. Storage capacity of the system permitted a 2.3 hr rain event. Construction materials used were chosen for resistance to the corrosive nature of the rain simulant, stability to ambient UV radiation, and resistance to penetration by sunlight. Simulated events were not synchronized to ambient events, but were scheduled to prevent moisture deficits. The system has reliably applied simulated rain to 90 red spruce trees for the past two experimental seasons, and has been tailored to meet some unique project needs including the size of the trees and the number of subplots to treat. (Author's abstract)
W91-04568

TOXICITY OF ZINC AND BLEACHED KRAFT MILL EFFLUENT TO LARVAL ENGLISH SOLE (PAROPHRYS VETULUS) AND TOPSMELT (ATHERINOPS AFFINIS).
California Univ., Bodega Bay. Bodega Marine Lab.
J. M. Shenker, and G. N. Cherr.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 680-685, September/October, 1990. 4 fig, 2 tab, 31 ref.

Descriptors: *Bioassay, *Fish, *Fish pathology, *Pulp wastes, *Toxicity, *Water pollution effects, *Zinc, Acute toxicity, Fish eggs, Growth, Larvae, Sole, Zinc sulfate.

Toxicity test protocols were developed for larvae of two species of marine fishes of the Pacific coast of the United States. During winter months, larvae were obtained from adult English sole (Parophrys vetulus) spawned in the laboratory. Newly-hatched, nonfeeding larvae were used in 96-hr experiments to determine their acute sensitivity to inorganic and organic toxicants. Exposure to $ZnSO_4$ produced a 96-hr LC50 of 14.5 mg Zn/L. A complex and variable organic effluent (untreated bleached kraft mill effluent; BKME) yielded 96-hr LC50s ranging from 1.2-9.3% BKME. Larvae were obtained from eggs collected from wild and laboratory populations of the spring and summer-spawning topsmelt (Atherinops affinis). Both acute (96-hr) mortality and longer-term (7-14 days) growth responses of topsmelt larvae to BKME were determined. Acute toxicity levels (96-hr LC50s) ranged from 6.2-9.7% BKME. No Observed Effect Levels (NOELs) for 7 and 14 day exposures ranged from 1.0-3.0% BKME. Larval growth was the most sensitive indicator of toxicity in two of the six experiments. In the other four trials, significant mortality occurred at lower BKME concentrations than did growth inhibition. Both the English sole and topsmelt bioassays indicated significant variability in BKME toxicity. (Author's abstract)
W91-04571

EFFECTS OF CADMIUM IN FRESHWATER CLAMS. I. INTERACTION WITH ESSENTIAL ELEMENTS IN ANODONTA CYGNEA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
J. Hemelraad, D. A. Holwerda, H. J. A. Winjnne, and D. I. Zandee.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 686-690, September/October, 1990. 2 fig, 2 tab, 16 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Clams, *Heavy metals, *Mollusks, *Toxicity, *Water pollution effects, Animal physiology, Hemolymph, Ligands, Magnesium, Sodium, Tissues, Zinc.

The elemental composition of the freshwater clam, Anodonta cygnea, was investigated in response to exposure to cadmium at 50 ppb Cd during 12 weeks. Accumulation of cadmium affected the composition in various tissues and hemolymph. From 2 to 8 weeks of exposure considerable loss of sodium occurred, to about half the levels in control animals. During the last four weeks of exposure, sodium concentrations stabilized at the decreased level while those of potassium started to decline. Minor changes were noticeable for other elements. Calcium and iron tended to increase in all organs examined while magnesium levels remained constant. Zinc increased slightly during exposure to cadmium. For some elements, especially zinc and sulfur, hemolymph concentrations showed a response opposite to those in tissues. Concentrations of Al, B, Ba Be, Ce, Co, Cr, Cu, Li, Mn, Mo, Ni, P, Pb, Sn, Sr, Ti, V, Y, and Zr did not change during Cd exposure. The small increase of zinc in most of the organs is attributable to an increase of specific metal binding proteins in the cytoplasm. The existence of such ligands has been shown in A. cygnea. Metallothionein (MT)-like proteins are capable of binding $Cd(2+)$ and $Zn(2+)$. Induction of MT-like proteins, as a result of Cd accumulation, will lead to a concomitant sequestering of zinc in the tissues. (See also W91-04573 and W91-04574) (Author's abstract)
W91-04572

EFFECTS OF CADMIUM IN FRESHWATER CLAMS. II. ULTRASTRUCTURAL CHANGES IN THE RENAL SYSTEM OF ANODONTA CYGNEA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
J. Hemelraad, H. J. Herwig, E. G. van Deonselaar, D. A. Holwerda, and D. I. Zandee.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 691-698, September/October, 1990. 6 fig, 1 tab, 22 ref.

Descriptors: *Animal physiology, *Cadmium, *Clams, *Cytology, *Heavy metals, *Kidneys, *Mollusks, *Toxicity, *Water pollution effects, Cadmium chloride, Chronic toxicity, Lysosomes, Metabolism, Mitochondria.

An ultrastructure study was made of the renal system of freshwater clams, Anodonta cygnea, that had been exposed to cadmium chloride (50 microg Cd/L) for 12 weeks. By stereological analysis an extended lysosomal system and a decreased number of mitochondria was apparent in the epithelial cells lining the proximal compartment of the kidney. The increase of the lysosomal system was mainly accountable to the appearance of a distinct type of lysosome, that accumulated in the apical cell region. The decrease of the mitochondrial population was accompanied by a considerable swelling of the individual mitochondria. Finally, a severe reduction of the glycogen stores was noticed. Similar, but less obvious, changes occurred in the distal kidney compartment. The results suggest that long-term exposure of Anodonta cygnea to cadmium stimulates the lysosomal system and disturbs the function of organelles involved in the energy metabolism of resorptive kidney cells. (See also W91-04572 and W91-04574) (Author's abstract)
W91-04573

EFFECTS OF CADMIUM IN FRESHWATER CLAMS. III. INTERACTION WITH ENERGY METABOLISM IN ANODONTA CYGNEA.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
J. Hemelraad, D. A. Holwerda, H. J. Herwig, and D. I. Zandee.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 699-703, September/October, 1990. 1 fig, 1 tab, 19 ref.

Descriptors: *Animal physiology, *Cadmium, *Clams, *Heavy metals, *Metabolism, *Toxicity, *Water pollution effects, Chronic toxicity, Glucose, Glycogen, Lactate, Mitochondria, Proteins.

Freshwater clams, Anodonta cygnea, were exposed to cadmium, at 50 ppb, to investigate the effects of semi-chronic exposure on energy metabolism. Parameters examined included: adenylate energy charge (AEC), glycogen content, blood glucose and protein concentration, the accumulation of anaerobic metabolic end products, (lactate and succinate), and mitochondrial NADH-oxidase activity. In all tissues, AEC was significantly lowered after 12 weeks. Glycogen contents of the separate organs, except for the gills, were diminished to one half those of control animals. Hemolymph glucose increased between 4 and 8 weeks, whereas protein in hemolymph steadily decreased, to about one half the concentration of controls at 12 weeks. Lactate increased in mantle and midgut gland, whereas in gill only an initial accumulation was found after 2 weeks of exposure. Succinate concentrations increased in all organs between 4 and 8 weeks of Cd exposure. Thereafter, no further accumulation occurred. From the onset of exposure to cadmium there was a gradual reduction of NADH-oxidase activity of gill mitochondria, down to 60% of the control value after 12 weeks. The data indicate an impairment of oxidative carbohydrate metabolism that is brought about by a metabolic blockade, rather than by (partial) anaerobiosis as a consequence of shell closure. (See also W91-04572 and W91-04573) (Author's abstract)
W91-04574

EFFECT OF COPPER ON THE EMBRYONIC DEVELOPMENT AND HATCHING OF SEPIA OFFICINALIS L.
Katholieke Univ. Nijmegen (Netherlands). Dept. of Zoology I.
W. P. Paulij, W. Zurburg, J. M. Denuce, and E. J. van Hannen.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 797-801, September/October, 1990. 6 fig, 1 tab, 23 ref.

Descriptors: *Copper, *Fish physiology, *Heavy metals, *Water pollution effects, Cuttlefish, Embryos, Hatching rate, Morphology, Perivitelline fluid.

In order to measure the effects of copper on embryonic development and hatching of the cuttlefish (Sepia officinalis), embryos were exposed to a range of copper concentrations. It was found that copper exerts a profound effect on both hatching stage and time-to-hatching. At high copper concentrations (50-200 ppb $Cu(2+)$), the embryos hatch earlier than the controls but have a lower survival potential. No external morphological malformations were observed. Although copper did not accumulate in the embryo or in the vitellus, it was absorbed by the envelope and/or the chorion. It is possible that copper changes the physicochemical properties of the envelope and/or the chorion, and in the late embryonic stages the protection by either one could decline. It is possible that the concentration of copper in the perivitelline fluid surrounding the embryo increases to a point that the copper affects the embryo and causes premature hatching. This would explain the influence of copper on hatching time. (White-Reimer-PTT)
W91-04581

CONCENTRATIONS OF BORON, MOLYBDENUM, AND SELENIUM IN CHINOOK SALMON.
National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.
For primary bibliographic entry see Field 5B.
W91-04590

AIR TOXICS PROJECT STUDIES HEALTH RISKS FROM WASTEWATER TREATMENT PLANT EMISSIONS.
Pirnie (Malcolm), Inc., White Plains, NY.
For primary bibliographic entry see Field 5D.
W91-04597

PLASMA VITELLOGENIN LEVELS IN PRE-SPAWNING RAINBOW TROUT, ONCORHYNCHUS MYKISS, DURING ACID EXPOSURE.
Concordia Univ., Loyola Campus, Montreal (Quebec). Dept. of Biology.
R. L. Roy, S. M. Ruby, D. R. Idler, and Y. So.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 803-806,

1990. 2 fig, 2 tab, 17 ref.

Descriptors: *Acid rain effects, *Acidic water, *Fish eggs, *Immunoassay, *Spawning, *Trout, *Vitellogenin, *Water pollution effects, Bioassay, Biochemical tests, Blood, Fish physiology, Hydrogen ion concentration, Proteins, Sublethal effects.

Vitellogenic Rainbow trout (Oncorhynchus mykiss) were exposed to pH 7.6, 5.6, and 4.5 for 20 days. Plasma vitellogenin (Vg) which is an indicator of the level of exogenous yolk precursors synthesized in the liver, and transported to the ovary was measured in sexually maturing females using a sensitive homologous radioimmunoassay specific for rainbow trout. During the September-October experiments, Vg levels significantly increased at pH 7.6 and 5.6 over the 20-day exposure period. At pH 4.5, however, Vg levels did not change during the experimental period. Based on the differences between day 0 and 20 plasma Vg levels, females at pH 7.6, 5.6, and 4.5 produced 0.357, 0.188 and 0.084 mg/mL/day Vg, respectively. The use of this sensitive homologous radioimmunoassay has confirmed the effect upon the reproductive mechanism of vitellogenesis at pH 4.5. Lower levels of this important yolk source in the oocyte could alter the successful development of the embryo during later stages of development. This assay provides a direct measure of Vg levels and permits the most accurate assessment to date of the effect of acid stress on Vg yolk production in rainbow trout. (Author's abstract)
W91-04609

FLOW CYTOMETRIC COMPARISON OF DNA CONTENT AND GLUTATHIONE LEVELS IN HEPATOCYTES OF ENGLISH SOLE (PAROPHYRS VETULUS) FROM AREAS OF DIFFERING WATER QUALITY.
Pacific Northwest Research Foundation, Seattle, WA.
N. K. Jenner, G. K. Ostrander, T. J. Kavanagh, J. C. Livesey, and M. W. Shen.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 807-815, 1990. 2 fig, 2 tab, 42 ref. NIH, NIEHS Grant ES04370 and Post-doctoral Environmental Pathology Training Grant ES07032.

Descriptors: *Cytology, *DNA, *Fish diseases, *Fish pathology, *Glutathione, *Liver, *Sole, *Toxicology, *Water pollution effects, Animal tissues, Bioassay, Carcinogens, Chronic effects, Fish toxins, Population exposure, Puget Sound.

English sole (Parophyrs vetulus) in Puget Sound, Washington are at risk of hepatocarcinogenesis specifically in areas adjacent to polluting industrial effluents. A question concerning population and ecosystem survival is whether any of the effects of etiopathologic change are reversible. This has been approached by looking for evidence of tumor accelerating effects in an exposed population. Cellular parameters were determined by flow cytometry for hepatocytes of English sole. Cells containing hyperdiploid DNA not present in fish from reference waters, Port Madison, were found in all non-tumor-bearing and tumor bearing fish taken from a polluted site. Eagle Harbor, where incidence of hepatic neoplasia approaches 30%. Induction of altered DNA content in the exposed general hepatocyte population suggests environmental induction rather than an association with lesions per se. In contrast, glutathione levels in hepatocytes (0.8 to 3.2 nmol/mg protein), were little influenced by the exposure site, consistent with the apparent lack of protection against chemically induced carcinogenesis in English sole. Association of altered DNA content with exposure site is significant for its potential contribution to biological acceleration and evidence of tumor promotion found at the tissue and organismic levels. The results support the notion that hepatocarcinogenesis in English sole in Eagle Harbor has a multi-year exposure etiology, in which potentially reversible accelerating influences have a role, and that glutathione conjugation is an inadequate mode of detoxification for these fish. (Author's abstract)
W91-04610

CHANGES IN INTRACELLULAR FREE AMINO ACIDS IN TISSUES OF THE CAGED MUSSEL, ELLIPTIO COMPLANATA, EXPOSED TO CONTAMINATED ENVIRONMENTS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
K. E. Day, J. L. Metcalfe, and S. P. Batchelor.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 816-827, 1990. 1 fig, 8 tab, 37 ref.

Descriptors: *Amino acids, *Biochemical tests, *Freshwater mussels, *Mussels, *Population exposure, *Stream pollution, *Water pollution effects, Agricultural runoff, Animal physiology, Animal tissues, Bioassay, Gills, Mollusks, Municipal wastes, Muscle, Quebec, Sublethal effects, Tissue analysis, Toxicity.

Intracellular tissue concentrations of free amino acids (FAA) were monitored in caged mussels (Elliptio complanata) exposed in situ for 27 to 29 days and 77 to 79 days in the Yamaska River watershed (Quebec, Canada). Total concentrations of FAA (nmol/mg wet weight) increased in both mantle and adductor muscle tissue at several sites impacted by agricultural runoff and urban effluent from municipal sewage and light industries, when compared to levels in mussels located at a site with little anthropogenic impact. Consistent changes in the percent composition of individual FAA to the total FAA pool included decreases in serine, threonine, glycine and valine as well as increases in glutamic acid and glutamine at 27 to 29 days, but results were not consistent with longer exposure and varied amongst sites. Few changes in total or individual FAA were observed in gill tissue. Results suggest that increases and/or decreases in total FAA in some tissues of freshwater bivalves may be indicative of generalized stress induced by a variety of environmental factors and may be useful as an in situ biochemical index of toxicity. (Author's abstract)
W91-04611

SUBCHRONIC EFFECTS OF SODIUM SELENITE AND SELENOMETHIONINE ON SEVERAL IMMUNE-FUNCTIONS IN MALLARDS.
Corvallis Environmental Research Lab., OR.
A. Fairbrother, and J. Fowles.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 836-844, 1990. 7 fig, 2 tab, 39 ref.

Descriptors: *Ducks, *Immunoassay, *Selenium, *Selenomethionine, *Water pollution effects, Animal tissues, Bioassay, Heavy metals, Sublethal effects, Tissue analysis, Toxicity, Water birds.

The subchronic effects of selenomethionine (SeM) and sodium selenite (SeL) on several immunologic, hematologic, and serologic parameters in mallards were measured using concentrations in drinking water of 0, 0.5, and 3.5 mg/L selenium (Se) as SeL and 2.2 mg/L (Se) as SeM. Cyclophosphamide (CP) was used as an immunosuppressive control at 20 mg/L. A battery of in vivo and in vitro immunologic assays was performed on each bird throughout the 12 week study. The SeM-treated birds displayed a significantly impaired delayed-type hypersensitive (DTH) response to tuberculin (M. bovis), as measured by the number of positive reactions present 24 hours post PPD challenge ($p < or = 0.05$). The SeM-treated group also exhibited a significantly increased serum alanine aminotransferase (ALT) activity and an increased plasma glutathione peroxidase (GPX) activity ($p < or = 0.05$). Selenium concentration in the liver and breast muscle of SeM-treated birds was significantly elevated 4 and 14-fold, respectively, over controls ($p < 0.05$). Body weight and water consumption of treated birds did not differ from controls and organ weights were not significantly affected by any Se treatment. Sodium selenite-treated birds displayed no detectable differences in immune-function or Se accumulation in tissues as compared to controls. Serum ALT activity was significantly increased in the 3.5 mg/L group, although to a lesser extent than in SeM-treated birds. Cyclophosphamide significantly depressed white blood cell number, testes, weights, and also suppressed the DTH reaction. Concentrations of Se as SeL did not affect the immune system, whereas low concentrations of SeM (2.2 mg/L Se) appeared to suppress certain aspects of the mallard immune response. (Author's abstract)
W91-04612

INFLUENCE OF IN VIVO EXPOSURE TO TRIBUTYLTIN ON REACTIVE OXYGEN FORMATION IN OYSTER TOADFISH MACROPHAGES.
Virginia Inst. of Marine Science, Gloucester Point.
C. D. Rice, and B. A. Weeks.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 854-857, 1990. 3 fig, 18 ref.

Descriptors: *Antifoulants, *Fish, *Macrophages, *Organotin compounds, *Tin, *Toadfish, *Toxicity, *Toxicology, *Water pollution effects, Bioassay, Blood, Dose-response relationships, Fish physiology, Immunoassay, In vivo tests, Luminescence, Sublethal effects.

The influence of in vivo tributyltin (TBT) exposure on macrophage activation was compared to previously reported responses resulting from in vitro exposure. Oyster toadfish (Opsanus tau) were treated weekly for six weeks with either sham, vehicle, 0.250, 0.750, or 2.5 mg/kg TBT. Resident peritoneal macrophages were isolated and chemiluminescence stimulated by TBT (50 micrograms/L) and synergistic combinations of the tumor promotor myristate acetate (PMA) and calcium ionophore (A23187) was compared between treatment groups. Chemiluminescence was reduced in a dose-dependent manner in response to both PMA with A23187 and TBT (50 micrograms/L) stimulation. The intracellular signal transduction involved in this chemiluminescence primarily involves the mobilization of calcium ions and subsequent events. It is suggested that a mode of toxicity of TBT to macrophage function is linked to an interference of calcium flux by affecting membrane integrity. (Author's abstract)
W91-04614

ULTRASTRUCTURAL ALTERATIONS IN THE RENAL EPITHELIUM OF CADMIUM-TREATED LITTORINA LITTOREA (L).
Universidad del Pais Vasco, Bilbao (Spain). Zientzi Fakultatea.
J. A. Marigomez, M. P. Cajaraville, E. Angulo, and J. Moya.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 863-871, 1990. 27 fig, 30 ref. Basque Government Project X-86.041.

Descriptors: *Animal pathology, *Cadmium, *Gastropods, *Kidneys, *Tissue analysis, *Toxicity, *Water pollution effects, Animal tissues, Bioassay, Cytology, Heavy metals, Sublethal effects.

Ultrastructural studies have been made to assess the effects of the sublethal exposure to cadmium on the kidney of the prosobranch gastropod (common periwinkle) Littorina littorea. Groups of winkles were subjected to cadmium exposure at the sublethal concentrations of 0, 0.5, and 1.25 mg Cd/L in a double series for 27 days. During the experimental conditions, cadmium concentration in the kidney was dose and time-dependent. Two types of response were found; one includes the increase in excretory activity after exposure to low cadmium concentrations or to high concentrations at short periods of time. The second consists of the pathological effects produced by stronger treatments. Results indicate that increased excretion and protein synthesis lead to alterations in cellular transport which result in a saturation of the homeostatic regulatory capability. Subsequently, cellular autolysis takes place resulting in nuclear pycnosis and cytoplasmatic hydropic degeneration. The resistance of the plasma membrane and the junctional complexes maintain the structural consistence of the epithelium, which lies on a reduced blood sinus with increased amounts of hemocytes. These observations agree with the general results on subacute toxicity in a wide range of animal groups, but

differ from those concerning direct poisoning due to cadmium in phylogenetically close species. (Author's abstract)
W91-04616

EFFECTS AND FATE OF CADMIUM DURING TOXICITY TESTS WITH CHIRONOMUS RIPARIUS; THE INFLUENCE OF FOOD AND ARTIFICIAL SEDIMENT.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
D. Pascoe, A. F. Brown, B. M. J. Evans, and C. McKavanagh.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 872-877, 1990. 3 fig, 6 tab, 19 ref. NERC Research Grant GR36104.

Descriptors: *Cadmium, *Midges, *Path of pollutants, *Sediment contamination, *Toxicity, *Water pollution effects, Bioassay, Dose-response relationships, Fate of pollutants, Foods, Heavy metals, Laboratory methods, Larvae, Median tolerance limit, Mortality.

Chironomus riparius (Diptera: Insecta) has been recommended for use in the assessment of sediment toxicity. The separate and joint effects of two factors, i.e., the presence of food and artificial sediment during a test, on the response of the benthic detritivorous larvae of Chironomus riparius to cadmium were examined. Using a range of cadmium concentrations (30 to 4200 mg/L), the following data were obtained: the mortality response with increasing exposure time and the median lethal (LT50) time at 70 to 2500 mg Cd/L; the 24 hour median lethal concentration or LC50 (2030 to 3180 mg Cd/L; the 48 hour LC50 (270 to 1030 mg Cd/L; and the 96 hour LC50 (82 to 155 mg Cd/L). These tests with fourth instar C. riparius larvae revealed that the presence of food, either alone or incorporated into artificial sediment, increased the apparent toxicity of cadmium, while the presence of artificial sediment alone decreased toxicity. An additional series of experiments was devised to examine the chemical fate and partitioning of cadmium within the various compartments of a static toxicity test system. A rapid transfer of cadmium from the test solution to the food or food-artificial sediment mixture was demonstrated. (VerNooy-PTT)
W91-04617

SOME EVIDENCE FOR AN EFFECT OF INGESTED PETROLEUM ON THE FERTILITY OF THE MALLARD DRAKE (ANAS PLATYRHYNCHOS).
California Univ., Santa Barbara. Dept. of Biological Sciences.
W. N. Holmes, and K. P. Cavanaugh.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 898-901, 1990. 2 tab, 19 ref.

Descriptors: *Ducks, *Fertility, *Oil, *Oil pollution, *Toxicity, *Water pollution effects, *Waterfowl, Bioassay, Foods, Morbidity, Sublethal effects.

The male and female of monogamous pairs of mallard ducks were housed separately on each side of a removable wire-mesh partition and each bird was fed either uncontaminated food or food that had been contaminated with South Louisiana crude oil (3 ml/100 g dry weight food). Food was removed from both sides of the cage for five hours each day, and during this interval the partition was removed to permit the birds to interact physically. When both sexes consumed uncontaminated food, the imposition of this interrupted feeding regime did not alter the normal temporal pattern of ovarian development in the female, and the ability of the male to fertilize eggs laid by the female was not impaired. When the male, but not the female, consumed petroleum-contaminated food, ovarian development was normal but the ability of the male to fertilize the eggs was significantly reduced. However, when only the female consumed contaminated food, ovarian development was slowed significantly and the frequency of fertilization was lowered to the same extent that it was when only the male consumed contaminated food. These effects suggest that ingested petroleum contaminants may impair the development of photostimulated gonadal endocrine function in both the male and the female. (Author's abstract)
W91-04619

EFFECTS OF EXPOSURE OF INCUBATING ADULT AND YOUNG HERRING GULLS TO A SIMULATED NO. 2 FUEL OIL SLICK.
Canadian Wildlife Service, Ottawa (Ontario). Wildlife Toxicology Div.
A. Harfenist, A. P. Gilman, and K. L. Maus.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 902-906, 1990. 3 tab, 22 ref.

Descriptors: *Eggs, *Embryonic growth stage, *Gulls, *Oil pollution, *Oil slicks, *Toxicity, *Water pollution effects, Bioassay, Canada, Great Lakes, Hatching, Incubation, Mortality, Population exposure, Sublethal effects, Survival, Water birds.

Naturally incubating herring gulls (Larus argentatus) were exposed to No. 2 fuel oil. The gulls were treated either early (seven to ten days after clutch completion) or late (when the second egg of the clutch reached the pip stage) in incubation. Hatching success of eggs of adults oiled early in incubation was reduced at 321 mL oil/sq m and survival of young to seven days post-hatch was reduced at both 107 and 321 mL/sq m. This decrease in survival at 107 mL/sq m suggests that a concentration of oil which is not lethal to the embryos may have a sublethal effect which reduces chick viability. When adults were oiled late in incubation, the only effect noted was decreased hatching success at 321 mL/sq m. Chicks between five and nine days of age which were exposed to an artificial slick of 321 mL No. 2 fuel oil/sq m exhibited decreased survival to seven days post-treatment. Since 107 mL/sq m is more than 20 times the maximum thickness of No. 2 fuel oil slicks which have been measured on the Great Lakes, a single exposure of an adult at the incubation stages tested or of a young chick to a free-floating oil slick would probably not cause a significant reduction in hatching success or survival of young. The effects of repeated exposure to a fresh fuel oil slick are unknown. (Author's abstract)
W91-04620

EFFECTS OF DICOFOL ON MALLARD EGGSHELL QUALITY.
NSI Technology Services Corp., Corvallis, OR.
J. K. Bennett, S. E. Dominguez, and W. L. Griffis.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 907-912, 1990. 5 tab, 18 ref.

Descriptors: *Dicofol, *Ducks, *Eggs, *Embryonic growth stage, *Halogenated pesticides, *Pesticide toxicity, *Pesticides, *Water pollution effects, Bioassay, Eggshells, Morbidity, Population exposure, Toxicity.

Dicofol is an organochlorine acaracide structurally similar to DDE and there is concern that it may effect avian reproduction. Effects of dietary dicofol on mallard (Anas platyrhynchos) egg production and eggshell quality were evaluated; the mallard is moderately sensitive to DDE shell-thinning toxicity. Hens in egg production were fed either 0, 3, 10, 30, or 100 micrograms/g dicofol for 42 days (the formulation of dicofol contained < 0.1% DDT-related impurities). A positive control study was also conducted in which mallard hens in egg production were fed 0, 3, 10, and 100 micrograms/g DDE for 42 days. Egg weight, shell thickness, shell strength, and dried shell weight were measured for all eggs produced. Egg production was not affected by dicofol diets, but the percentages of cracked and soft-shelled eggs from birds on the 100 micrograms/g dicofol diet were significantly ($p < 0.05$) greater. Shell strength, thickness, and weight were negatively related to dicofol dietary concentrations. Shell quality was reduced after one day of treatment with some dicofol diets. Effects of similar character and magnitude were observed in eggs from positive control birds fed DDE. The data demonstrate that dietary exposure to the technical formulation of dicofol that contains < 0.01% DDT-r significantly affected mallard eggshells. (Author's abstract)
W91-04621

TOXICITY OF PHENOL TO THE FRESHWATER CRUSTACEAN ASELLUS AQUATICUS (L.) DURING EPISODIC EXPOSURE--RELATIONSHIP BETWEEN SUB-LETHAL RESPONSES AND BODY PHENOL CONCENTRATIONS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
C. P. McCahon, S. F. Barton, and D. Pascoe.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 6, p 926-929, 1990. 1 fig, 3 tab, 43 ref.

Descriptors: *Isopods, *Phenols, *Toxicity, *Toxicology, *Water pollution effects, Animal tissues, Bioassay, Crustaceans, Immobilization, Population exposure, Spills, Sublethal effects, Temperature effects, Tissue analysis.

Little is known about the effects on biota of short exposure periods to relatively high concentrations of phenol as might occur following a deliberate or accidental discharge to a receiving water. In this study, the toxicity of phenol to the freshwater crustacean Asellus aquaticus was assessed at 10 and 20 C, using 100 mg/L and 150 mg/L phenol. Response criteria were immobilization and recovery. The time to immobilization was significantly faster at 10 C than at 20 C at 100 mg/L phenol (197.1 versus 676.8 min), but not at 150 mg/L (43.4 versus 45.6 min, respectively). Recovery from immobilization in clean water was significantly faster at 20 C (5.7 and 9.2 min) than at 10 C (17.0 and 25.8 min). Both response criteria correlated well with recorded body concentrations of phenol. (Author's abstract)
W91-04622

TOXICITY OF AN OIL DISPERSANT TO THE EARLY LIFE STAGES OF FOUR CALIFORNIA MARINE SPECIES.
California Univ., Santa Cruz. Inst. of Marine Sciences.
M. M. Singer, D. L. Smalheer, R. S. Tjeerdema, and M. Martin.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1387-1395, 1990. 5 fig, 2 tab, 34 ref.

Descriptors: *Abalone, *Dispersants, *Kelps, *Oil dispersants, *Opossum-shrimp, *Surfactants, *Topsmelt, *Toxicity, *Toxicology, *Water pollution effects, Bioassay, Crustaceans, Immature growth stage, Marine animals, Oil spills, Population exposure.

Of the six dispersant chemicals now approved for use on oil spills in California, Corexit 9527(TM) is most commonly stockpiled by oil response cooperatives. Continuous-flow toxicity tests using the oil dispersant Corexit 9527, a mixture of nonionic (48%) and anionic (35%) surfactants in a hydrocarbon solvent (17%), were performed on the early life stages of four California marine species. Newly released zoospores of the giant kelp, Macrocystis pyrifera, embryos of the red abalone, Haliotis rufescens, 4-day old juveniles of the mysid, Holmesimysis costata and 10 day old larvae of the topsmelt, Atherinops affinis, were all used in triplicate 48 and 96 hour tests. Quantitative verification of dispersant concentrations using ultraviolet spectrophotometry was performed twice daily during testing. Results indicated growth of kelp gametophytes was significantly reduced at < 2.4 ppm after a 48 hour exposure. Of the three animals tested, developing red abalone were the most sensitive (no observed effect concentration; NOEC = 0.63 to 1.50 ppm; LC50 = 1.60 to 2.20 ppm). Mysid juveniles were intermediate in sensitivity (NOEC = 1.66 to 4.20 ppm; LC50 = 4.26 to 7.26 ppm), whereas topsmelt larvae were the least sensitive (NOEC = 12.27 to 14.18 ppm; LC50 = 25.51 to 40.63 ppm). Reproducibility of test data was

very high (coefficient of variation = 15.7 to 27.1%). (Author's abstract)
W91-04629

DERIVATION OF A FRESHWATER SILVER CRITERIA FOR THE NEW RIVER, VIRGINIA, USING REPRESENTATIVE SPECIES.
Biological Monitoring, Inc., Blacksburg, VA.
J. M. Diamond, D. G. Mackler, M. Collins, and D. Gruber.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 11, p 1425-1434, 1990. 4 fig, 5 tab, 23 ref.

Descriptors: *Bioassay, *Chronic toxicity, *Hazard assessment, *Silver, *Stream biota, *Toxicology, *Virginia, *Water pollution effects, *Water quality standards, Data interpretation, Invertebrates, New River, Population exposure, Sublethal effects.

The Environmental Protection Agency (EPA) has not published a 30 day average or continuous criterion for silver due to the apparent toxicity of this element and the lack of available chronic exposure data. Acute effects on nine species representative or indigenous to the New River, Virginia, and sublethal effects on three of those species using the Resident Species Approach were examined. The results showed that invertebrates were much more sensitive to silver than fish, including juvenile rainbow trout (Oncorhynchus mykiss). Hyalella azteca (amphipod) were the most sensitive species followed by the mayflies Stenonema sp. and Isonychia bicolor and the stonefly Leuctra sp. The Final Acute Value in this study was 1.32 micrograms/L total recoverable silver. In sublethal tests, Isonychia growth, as measured by the number of molts over time, was the most sensitive effect observed. Estimated acute:'chronic' ratios ranged from 2 to 34 with Corbicula fluminea having the largest ratio. Study results, along with available published data, suggest a Final Chronic Value of 0.13 micrograms/L total silver which is approximately one-half the level obtained using the EPA acute formula and ambient water hardness. These results suggest that a continuous criterion for silver may be predictable using the hardness-dependent formula and a safety factor of 0.5. (Author's abstract)
W91-04632

EFFECTS OF ACIDIC PRECIPITATION ON THE WATER QUALITY OF STREAMS IN THE LAUREL HILL AREA, SOMERSET COUNTY, PENNSYLVANIA, 1983-86.
Geological Survey, Harrisburg, PA.
J. L. Barker, and E. C. Witt.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 89-4113, 1990. 72p, 19 fig, 15 tab, 36 ref. Prepared in cooperation with U.S. Environmental Protection Agency.

Descriptors: *Acid rain, *Acid rain effects, *Path of pollutants, *Pennsylvania, *Water chemistry, *Water pollution effects, *Water quality, Acid neutralizing capacity, Acidification, Aluminum, Bens Creek, Chlorides, Geochemistry, Hydrogen ion concentration, Nitrates, Precipitation, Runoff, Silica, Snowmelt, Sulfates.

Five headwater streams in the Laurel Hill area in southwestern Pennsylvania were investigated from September 1983 through February 1986 to determine possible effects of acidic precipitation on water quality. Precipitation in the Laurel Hill area is among the most acidic in the Nation, with a mean volume-weighted pH of 4.06. Sulfate is the dominant acid-forming anion, averaging 3.6 mg/L or about 50 kg/hectare in wet deposition alone. Nitrate averages about 2 mg/L or 7 kg/hectare in the study area. Stream chemistry in the five streams is quite variable and apparently is influenced to a large degree by the bedrock geology and by small amounts of alkaline material in watershed soils. Three of the five streams with no or little acid-neutralizing capacity presently are devoid of fish because of low pH and elevated aluminum concentrations. Aluminum concentrations increase in the other two streams during rainfall and snowmelt despite comparatively higher base flow and acid-neutralizing capacities. Comparison of the chemistry of streamflow during 14 storm events at South Fork Bens Creek and North Bens Creek reveals similar chemical responses when discharge suddenly increases. Concentrations of dissolved metals and sulfate increased during stormflow and snowmelt runoff, whereas concentrations of base cations, silica, and chloride decreased. Nitrate concentrations were not affected by rainfall runoff but tended to increase with snowmelt runoff. (Author's abstract)
W91-04636

CORRELATION OF CADMIUM SHELL-WEIGHT INDEX WITH ENVIRONMENTAL STRESS INDICATORS AT THE CELLULAR AND ORGANISMIC LEVELS IN LITTORINA LITTOREA.
Universidad del Pais Vasco, Bilbao (Spain). Zientzi Fakultatea.
For primary bibliographic entry see Field 5A.
W91-04719

TAXONOMIC LEVEL AND SAMPLE SIZE SUFFICIENT FOR ASSESSING POLLUTION IMPACTS ON THE SOUTHERN CALIFORNIA BIGHT MACROBENTHOS.
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
S. P. Ferraro, and F. A. Cole.
Marine Ecology Progress Series MESEDT, Vol. 67, No. 3, p 251-262, November 1990. 5 fig, 5 tab, 70 ref.

Descriptors: *Benthos, *Network design, *Sampling, *Statistical analysis, *Water pollution effects, Analysis of variance, Comparison studies, Data interpretation, Error analysis, Taxonomy.

Macrobenthic data from samples taken in 1980, 1983, and 1985 along a pollution gradient in the Southern California Bight were analyzed at five taxonomic levels (species, genus, family, order, phylum) to determine the taxon and sample size sufficient for assessing pollution impacts on five measures of community structure. Two statistical designs were compared: a t-test for differences between reference and impacted stations where the error term was (1) among-year variation at the reference station (impact effects design), (2) replicate (within-station) sampling error (location effects design). The estimated statistical power (1-beta) to detect impacts was a function of type and magnitude of impact, level of taxonomic identification, the statistical design, and the sample size (ni = number of sampling years at the reference station for the impact effects design, and n1 = number of replicate samples per station for the location effects design). Four replicate 0.1 sq m van Veen grabs per station were needed to ensure community-wide, unbiased estimates of Shannon's, 1-Simpson's and McIntosh's Index. Family-level identification appeared to be a good choice for assessing pollution impacts at the study site as it ensured a high probability (1-beta > or = 0.80) of detecting intermediate or larger impacts on most (impact effects design) or all (location effects design) of five measures of community structure when ni and n1 > or = 4. The level of taxonomic identification and sample size should be considered along with other sampling variables (e.g. sample unit size, sieve mesh size) when seeking a statistically rigorous, cost-effective study design sufficient to meet pollution assessment objectives. (Author's abstract)
W91-04721

PERSISTENCE OF GENETICALLY ENGINEERED ERWINIA CAROTOVORA IN PERTURBED AND UNPERTURBED AQUATIC MICROCOSMS AND EFFECT ON RECOVERY OF INDIGENOUS BACTERIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 2H.
W91-04723

IMPACT OF VOLATILE AROMATIC HYDROCARBONS, ALONE AND IN COMBINATION, ON GROWTH OF THE FRESHWATER ALGA SELENASTRUM CAPRICORNUTUM.
Waterloo Univ. (Ontario). Dept. of Biology.
D. C. Herman, W. E. Inniss, and C. I. Mayfield.
Aquatic Toxicology AQTODG, Vol. 18, No. 2, p 87-100, 1990. 5 fig, 2 tab, 29 ref.

Descriptors: *Aromatic compounds, *Bioassay, *Chrysophyta, *Hydrocarbons, *Synergistic effects, *Toxicity, Algal growth, Benzenes, Toluenes, Xylenes.

A sealed, air-tight exposure system was used to test the toxicity of aromatic hydrocarbons on the representative green alga, Selenastrum capricornutum. The growth of S. capricornutum was inhibited within the sealed flasks due to restricted gas exchange, but inhibition was overcome by the addition of a sodium bicarbonate solution (0.4% w/v) to the growth medium. Toxicity was determined as the concentration required to reduce growth by 50% following an 8-day exposure period (EC50). Growth of algal cells was determined by direct counting with a hemocytometer. Relative toxicity of 6 aromatic hydrocarbons was, in order of increasing toxicity, benzene (EC50 = 41.0 mg/L), toluene (0.4 mg/L), ethyl-benzene (4.8 mg/L) and p-, m-, and, o-xylene (between 3.9-4.4 mg/L). Examination of the toxicity of hydrocarbon mixtures revealed an additive toxicological interaction between benzene, toluene and m-xylene, indicating that the toxicity of a mixture can be predicted from the sum of the toxicities of each component. A synergistic interaction was evident between benzene and toluene at higher concentration levels, but the interpretation of synergism is complicated by a rapid increase in sensitivity of algae to greater toluene concentrations. (Author's abstract)
W91-04734

USE OF ACETYLCHOLINESTERASE ACTIVITY TO DETECT SUBLETHAL TOXICITY IN STREAM INVERTEBRATES EXPOSED TO LOW CONCENTRATIONS OF ORGANOPHOSPHATE INSECTICIDES.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5A.
W91-04735

DISTRIBUTION AND ABUNDANCE OF PACHYMELANIA AURITA IN LAGOS LAGOON, NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Zoology.
E. A. Ajao, and S. O. Fagade.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 475-488, October 1990. 4 fig, 3 tab, 23 ref.

Descriptors: *Estuarine fisheries, *Gastropods, *Lagoons, *Mollusks, *Population density, *Water pollution effects, Environmental effects, Nigeria, Physicochemical properties, Spatial distribution, Textile mill wastes.

The distribution, abundance and life cycle of Pachymelania aurita Muller in Lagos lagoon were studied at 26 stations during the dry season (February) and wet seasons (June). At each station, physicochemical parameters were sampled and anthropogenic influences were noted. P. aurita occurred in large densities in the shallow shoal sands in the north and north-eastern rims of the lagoon where the bottom sediments were well-sorted and contained little or no silt. P. aurita is euryhaline and was observed in the lagoon year round. The species is unisexual and had a definite breeding season which coincided with the end of the rainy season and beginning of the dry season. The presence of varying sediment types was reflected in the level of associated organic matter. High organic matter at station 20 was associated with industrial wastes containing fibers from a textile mill. At stations 21 and 23 it was associated with the disposal of domestic sewage and at station 26 with dead decaying mangrove roots. The species is a ciliary feeder which would be limited in abundance in habitats containing high organic matter. (Geiger-PTT)
W91-04741

DIETARY ACCUMULATION AND SUSTAINED HEPATIC MIXED FUNCTION OXIDASE ENZYME INDUCTION BY 2,3,4,7,8-PENTACHLORODIBENZOFURAN IN RAINBOW TROUT.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
D. C. G. Muir, A. L. Yarechewski, D. A. Metner, W. L. Lockhart, and G. R. B. Webster.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 12, p 1463-1472, 1990. 3 fig, 4 tab, 33 ref.

Descriptors: *Bioaccumulation, *Chlorinated hydrocarbons, *Enzymes, *Path of pollutants, *Toxicity, *Trout, Water pollution effects.

Accumulation of and hepatic monooxygenase induction by 2,3,4,7,8-pentachlorodibenzofuran (PnCDF) were studied in juvenile rainbow trout (Onchorhynchus mykiss) by feeding treated food for 31 days followed by a 180 day depuration period. Efficiency of assimilation was 44 and 41% at exposure concentrations of 9.0 and 0.82 nanograms/g PnCDF, respectively. Depuration of PnCDF followed first-order kinetics with half-lives (based on toluene extraction of C14-radiolabel corrected for growth dilution) of 61 and 69 days at the low and high exposure concentrations, respectively. Monooxygenase enzyme induction measured by the ethoxyresorufin-O-deethylase (EROD) activity in individual trout livers was 84-and four-fold higher after 31 days of exposure to 9.0 and 0.82 nanograms/g, respectively, than in livers of unexposed fish. Sustained EROD activity at the high treatment concentrations was observed during the 180 day depuration phase. Ethoxyresorufin-O-deethylase activity declined at approximately half the rate of elimination of PnCDF. No significant differences between growth rates of treated and control fish were found. (Author's abstract)
W91-04745

TOXICITY OF CADMIUM IN SEDIMENTS: THE ROLE OF ACID VOLATILE SULFIDE.

Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
D. M. DiToro, J. D. Mahony, D. J. Hansen, K. J. Scott, and M. B. Hicks.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 12, p 1487-1502, 1990. 6 fig, 4 tab, 39 ref, append. EPA Cooperative Agreement CR812824-01.

Descriptors: *Bioavailability, *Cadmium, *Marine sediments, *Sulfides, *Toxicity, Amphipods, Heavy metals, Interstitial water, Sorption.

The toxicity of chemicals in sediments is influenced by the extent that chemicals bind to the sediment. Acid volatile sulfide (AVS) is the sediment phase that determines the LC50 for cadmium in the marine sediments tested. AVS is a reactive pool of solid phase sulfide that is available to bind with metals. Amphipod sediment toxicity tests were conducted in the laboratory and the observed amphipod LC50 on a normalized cadmium concentration basis is the same for sediments with over an order of magnitude difference in dry weight normalized cadmium LC50s. Because other toxic metals also form insoluble sulfides, it is likely that AVS is important in determining their toxicity in sediments as well. Most freshwater and marine sediments contain sufficient acid volatile sulfide for this phase to be the predominant determinant of toxicity. The other sorption phases are expected to be important only for low AVS sediments, for example, fully oxidized sediments. From the point of view of sediment quality criteria the other sorption phases would be important for metals with large partition coefficients and large chronic water quality criteria. (Author's abstract)
W91-04746

INVESTIGATION OF PREFERENCE-AVOIDANCE RESPONSES TO AN OIL REFINERY EFFLUENT WITH STRIPED BASS AND STEELHEAD TROUT.

Antigo City Engineer, WI.
R. S. Carr, M. E. Barrows, N. G. Reichenbach, G. M. DeGraeve, and T. L. Pollock.

Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 12, p 1513-1521, 1990. 1 fig, 5 tab, 20 ref.

Descriptors: *Bass, *Fish behavior, *Oil wastes, *Trout, *Water pollution effects, Amino acids, Phenols, San Francisco Bay, Toxicity.

Preference-avoidance tests using a modified Y-maze test apparatus were conducted with juvenile striped bass, Morone saxatilis, and steelhead (rainbow) trout, Oncorhynchus mykiss (formerly Salmo gairdneri), exposed to a refinery effluent discharged into San Francisco Bay. The test system was set up on site at the refinery, and the performance of the test system was validated using two reference materials, phenol (reference avoidant) and a mixture of amino acids (reference attractant). Both species of fish were tested at four effluent concentrations ranging from 0.1 to 10% with two different dilution waters, the receiving water and a known high-quality natural seawater. The results of this study indicated that juveniles of both species tended to avoid the effluent at concentrations that might be expected to occur within a short distance of the refinery outfall diffuser. At concentrations that would occur outside the zone of initial dilution, neither species of fish exhibited a preference of avoidance response to the refinery effluent. (Author's abstract)
W91-04747

PREPARATION OF BENTHIC SUBSTRATES FOR SEDIMENT TOXICITY TESTING.

Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.

For primary bibliographic entry see Field 5A.
W91-04748

RETROSPECTIVE COHORT MORTALITY STUDY OF CANCER AMONG SEWAGE PLANT WORKERS.

State Univ. of New York at Buffalo. School of Medicine.

For primary bibliographic entry see Field 5D.
W91-04754

EFFECTS OF ACID PRECIPITATION ON REPRODUCTION IN BIRDS.

Instituut voor Oecologisch Onderzoek, Heteren (Netherlands).
J. Graveland.

Experientia EXPEAM, Vol. 46, No. 9, p 962-970, September 15, 1990. 118 ref.

Descriptors: *Acid rain effects, *Acidification, *Birds, *Reproducibility, *Water birds, *Water pollution effects, Acidic water, Ecological effects, Environmental effects, Forest ecosystems, Literature review, Reviews, Transparency, Water pollution sources.

Acifidication in aquatic habitats reduces the reproductive success of both piscivorous and non-piscivorous birds, mainly by reducing the food supply. Piscivorous birds find some compensation in an increased transparency of the water, non-piscivorous birds in less competition for invertebrate prey by fish. Acidification in forests often has large impacts on insect populations but how this affects forest birds is unknown. Some wood peckers and nuthatches temporarily benefit from an increase in standing dead timber. In advanced stages of forest dieback the breeding density of forest birds is very much reduced, but species of open woodland increase. Calcium deficiency reduces the reproductive output of some passerine species, but the extent of this phenomenon is unknown. Increased exposure to toxic metals has reduced the reproductive success of some lake dwelling species. It is difficult to assess the effect of acid precipitation on birds since acidification affects ecosystems in many ways, the evidence is largely correlative and reliable estimates of the population size are often lacking. Future studies should concentrate on carefully selected indicator species suitable for detailed data collection. (Author's abstract)
W91-04774

ACUTE EPIDEMIC ALUMINIUM OSTEOMALACIA SECONDARY TO WATER SUPPLY CONTAMINATION.

Meath Hospital, Dublin (Ireland). Dept. of Clinical Medicine.
A. A. J. O'Brien, D. P. Moore, and J. A. B. Keogh.

Irish Journal of Medical Science IJMSAT, Vol. 159, No. 3, p 71-73, March 1990. 3 tab, 19 ref.

Descriptors: *Alum, *Aluminum, *Human diseases, *Water pollution effects, *Water treatment, Bone disorders, Ireland, Osteomalacia, Sand filtration, Water pollution.

The syndrome of aluminum osteomalacia is well recognized in patients on maintenance hemodialysis for many years. Water contamination is the major culprit in hemodialysis units. When the aluminum content of the water supply in the Hemodialysis Unit at Meath Hospital, Dublin, Ireland rose from <0.5 micromole/L to 6 micromoles/L over a two month period, bone biopsies and desferrioxamine infusion tests were carried out on 12 patients who had been on hemodialysis for less than one year and had normal serum aluminum levels. The patients had no bone symptoms. Eight patients had positive aluminum bone stains. This aluminum osteomalacia group had a mean parathyroid hormone concentration of 1.4 mg/ml, whereas the non-aluminum osteomalacia group had a mean parathyroid hormone level of 2.9 mg/ml. The difference in mean parathyroid hormone concentration is significant. There was no evidence of encephalopathy, fractures or microcytic anemia in the aluminum osteomalacia positive group. The aluminum contamination of the water supply occurred because of a change in the reservoir purification system from sand-filtration to alum. (Mertz-PTT)
W91-04779

LAKE ENRICHMENT AND THE STATUS OF WINDERMERE CHARR, SALVELINUS ALPINUS (L).

Freshwater Biological Association, Ambleside (England). Windermere Lab.
C. A. Mills, S. I. Heaney, C. Butterwick, J. E. Corry, and J. M. Elliot.

Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 167-174, 1990. 2 fig, 22 ref.

Descriptors: *Char, *England, *Eutrophication, *Fish conservation, *Lakes, *Trout, *Water pollution effects, Aquatic habitats, Climatic changes, Freshwater pollution, Genetics, Oxygen requirements, Population density, Sewage, Temperature, Trophic level.

All English populations of Arctic char, Salvelinus alpinus (L.) are found in the Lake District (northwest England). At least four races of char exist in Windermere, the largest lake in England; the North and South basins of the lake each contain two distinct races that spawn in autumn and spring, respectively. The spring spawners in both basins probably represent less than 15% of the total population in the lake. Changes in the population density of char in the lake are examined in relation to the trophic status of the lake. Other factors that could possibly affect the char population are reviewed, especially the influence of climate change. The greatest immediate problem confronting char populations in Windermere is the marked increase in deep water deoxygenation. Reduced oxygen concentrations will presumably restrict the char's feeding range during the summer months. A program for the reduction of sewage-borne phosphorus to Windermere has been started by North West Water, with the aim of reversing the process of eutrophication. A predicted change in climate could cause additional threats to the char population, because the clear eggs are extremely sensitive to temperatures above 8 C, especially during the first few days of development and again when close to hatching. (Brunone-PTT)
W91-04788

THREATS TO THE SURVIVAL OF ANADROMOUS FISHES IN THE RIVER TAGUS, PORTUGAL.

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C. A. Assis.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 225-226, 1990. 1 fig, 3 ref.

Descriptors: *Anadromous fish, *Aquatic habitats, *Endangered species, *Fish conservation, *Portugal, *Species diversity, *Tagus River, Dam construction, Fish behavior, Fish migration, Freshwater, Lamprey, Path of pollutants, Population density, River fisheries, Shad, Sturgeon, Water pollution effects.

The great majority of European anadromous fishes are threatened species. The River Tagus, on the Iberian Peninsula, is more than 1100 km in length. Four anadromous fish species occur in this basin but they no longer reach the upper part of the basin. In Portugal, the sea lamprey and the twaite shad are still common; the allis shad is rapidly declining; the river lamprey is rare. The sturgeon no longer occurs in the River Tagus. In the Tagus basin, countless sources of all types of industrial and urban pollution exist, whose effluents are not subjected, in most cases, to previous treatment. The estuary is completely surrounded by Lisbon and its suburbs, which produce an enormous amount of domestic sewage; additionally, there are some 600 sources of industrial pollution. Up river, in Portugal, the main sources of pollution are the cities of Santarem, Abrantes, Castelo Branco and Portalegre, and industries dealing with cellulose, oils for human food and milk and tomato derivatives. Although most anadromous fish species used to live in the whole Tagus basin, reaching its Spanish portion, they are now limited to the lower 200 km of the main Tagus river because of two dams which are impassable barriers. The dams are at Belver and at Castelo de Bode. The reservoir contains a landlocked population of allis shad which, due to its poor quality, has a low commercial value and is therefore not fished. The construction of two more dams is planned for the River Tagus. If provisions are not made to guarantee the passage of migratory fish, their progression up river will be even more limited than at present. Fisherman cause an impact on the anadromous fish stocks on two levels: pre-reproductive migrating adults are caught in large numbers in areas where they are forced to concentrate below the dams, and juveniles are caught in fishing gear utilized for other species in the estuary. To preserve the anadromous species, detailed studies on the bioecology of the migrant population should be promoted, levels of pollution should be decreased, functional and efficient fishways in dams should be provided, and closed fishing seasons should be created. (Brunone-PTT)
W91-04794

ENVIRONMENTAL PROTECTION IN EASTERN EUROPE.
Institute for Soil Fertility, Haren (Netherlands). Dept. of Soil Physics and Root Ecology.
For primary bibliographic entry see Field 5G.
W91-04817

BACTERIAL HETEROTROPHIC ACTIVITY IN THE RIVER SEINE: TRITIATED THYMIDINE AND LEUCINE INCORPORATION PROFILES (ACTIVITE BACTERIENNE HETEROTROPHE DANS LA SEINE: PROFILS D'INCORPORATION DE THYMIDINE ET DE LEUCINE TRITIEES).
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
P. Servais, and J. Garnier.
Comptes Rendus de l'Academie des Sciences (Serie 3) Sciences de la Vie CRAMED, Vol. 311, No. 10, p 353-360, November 1990. 3 fig, 11 ref. English summary.

Descriptors: *Aquatic bacteria, *Bacterial analysis, *France, *Organic matter, *Proteins, *Seine River, *Wastewater pollution, *Water pollution effects, Comparative studies, Deoxyribonucleic acid, Leucine, Paris, Protein synthesis, Radioactive tracers, Thymidine.

In aquatic ecosystems, the utilization of organic matter by heterotrophic microorganisms, especially bacteria, is a major process governing the function of these ecosystems. Therefore, a variety of methods have been proposed for measuring bacterial heterotrophic activity in aquatic ecosystems that are principally based on the use of radioactive tracers. A comparative study was conducted to evaluate two methods: the tritiated thymidine incorporation method based on the proportionality between DNA synthesis and the rate of bacterial division; and the use of tritiated leucine incorporation to evaluate the protein synthesis rate which can be a good estimation of bacterial production. The study was conducted on the River Seine in October 1989 at 18 stations along 300 km of river, between Montereau, at the confluence with the River Yonne, and Poses, near the estuary. The rate of thymidine incorporation along the course of the river was essentially characterized by low values upstream of Paris and a large increase in the area surrounding Paris, with a maximum value just downstream of the sewage treatment plant of Acheres. Similar trends were observed with the leucine incorporation method. The comparative study of leucine and thymidine incorporation rates, coupled with the bacterial enumerations, led to the distinction of two bacterial populations. The allochthonous populations brought by the urban sewage differed from the autochthonous population both morphologically (higher biovolume) and physiologically (higher ratio of leucine to thymidine incorporation rates). The allochthonous populations rapidly decreased after their input into the river; the disappearance processes seemed to be higher for this population than for the autochthonous bacteria. These large sized bacteria are indeed accessible to a wider number of grazers and their sedimentation should be higher. (White-Reimer-PTT)
W91-04837

CHEMICAL WEATHERING IN THE LOCH VALE WATERSHED, ROCKY MOUNTAIN NATIONAL PARK, COLORADO.
Wyoming Univ., Laramie. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2J.
W91-04926

INFLUENCE OF TEMPERATURE AND MINERAL SURFACE CHARACTERISTICS ON FELDSPAR WEATHERING RATES IN NATURAL AND ARTIFICIAL SYSTEMS: A FIRST APPROXIMATION.
Michigan State Univ., East Lansing. Dept. of Geological Sciences.
M. A. Velbel.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 3049-3053, December 1990. 1 tab, 47 ref. NSF Grant No. BSR-8514328.

Descriptors: *Acid rain effects, *Acidification, *Crystalline rocks, *Feldspar, *Geochemistry, *Silicates, *Temperature effects, *Weathering, Etch pits, Hydrogen ion concentration, Hydrolysis, Neutralization, Percolation, Soil formation.

Landscapes underlain by crystalline silicate bedrock are the most sensitive to acidification, because the silicate minerals of which they are composed do not react with throughgoing solutions quickly enough to neutralize the added acidity or to release sufficient quantities of base cations to the soil-exchange complex. Despite the abundance of published research on the geochemical kinetics of silicate mineral/water interactions, silicate-mineral weathering rates in natural systems are poorly understood. Rates of alkali feldspar hydrolysis in the near-neutral pH range up to 3 orders of magnitude slower in natural systems than in laboratory experiments. Correcting for differences in temperature between natural weathering and laboratory systems reduces the disparity by as much as a factor of 5. Any remaining disparity can be accounted for by differences in the ratio of effective surface area to total surface area; the ratio of effective-to-total surface area in natural systems is generally considerably smaller than in laboratory systems. This may be related to experimental preparation artifacts and to the fact that naturally weathered feldspars have lost much of their most reactive surface to the formation of etch pits. Hydrological factors such as inhomogeneous access of percolating fluids to mineral surfaces may also reduce the proportion of mineral surface area reacting in natural systems. (Brunone-PTT)
W91-04932

5D. Waste Treatment Processes

AEROBIC TREATMENT OF DAIRY WASTEWATER.
Hong Kong Univ. Dept. of Civil Engineering.
H. H. P. Fang.
Biotechnology Techniques BTECE6, Vol. 4, No. 1, p 1-4, Jan/Feb 90. 3 fig, 1 tab, 3 ref.

Descriptors: *Activated sludge process, *Carbon removal, *Dairy industry, *Food-processing wastes, *Nitrogen removal, *Wastewater treatment, Biological oxygen demand, Effluent charges, Kjeldahl procedure, Pilot plants, Sludge seeding.

A dairy plant which recovers casein and lactose from cheese whey had to pay a substantial monetary penalty in order to discharge its wastewater to the municipal sewer. This wastewater had an average biological oxygen demand (BOD5) of 1060 mg/L and an average total Kjeldahl nitrogen (TKN) of 109 mg/L. In order to reduce discharge costs, a pilot wastewater treatment facility was built on-site to examine the effectiveness of reducing the carbonaceous and nitrogenous pollutant levels in the plant wastewater by the activated sludge process. The pilot plant was designed to continuously treat 230 L/hr of plant wastewater and consisted of an equalization tank and three reactors in series, which were seeded with activated sludge from a local municipal secondary wastewater-treatment plant. With an overall retention time of 19.8 hrs, the final effluent contained 9 mg/L of BOD5 and 10 mg/L of TKN, corresponding to respective reductions of 99% and 91%. (Doyle-PTT)
W91-03969

DEEP WASTEWATER RESERVOIRS IN ISRAEL: EMPIRICAL DATA FOR MONITORING AND CONTROL.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
For primary bibliographic entry see Field 5E.
W91-04036

AUTOCATALYTIC MODEL FOR THE KINETICS OF BOD TEST.
Nanjing Inst. of Technology (China). Dept. of Applied Chemistry.
Y. Maoyu.
Water Research WATRAG, Vol. 24, No. 9, p 1091-1095, September 1990. 9 fig, 2 tab, 4 ref.

Descriptors: *Biochemical oxygen demand, *Kinetics, *Mathematical models, *Model studies, *Oxidation, *Wastewater analysis, *Wastewater treatment, *Water analysis, Biodegradation, Dissolved oxygen.

An autocatalytic model for the oxidation of carbonaceous matter is based on an analysis of BOD experimental results. The autocatalytic kinetics model can satisfactorily explain the problem of the lag period in BOD tests, as verified by experimental results. If the size of inocula and/or the microbial activities increases adequately, the autocatalytic kinetics model can be expressed as first-order kinetics. If the size of the inocula and/or the microbial activities increases greatly, the autocatalytic model follows second-order kinetics. By dilution the time courses of BOD were determined for three types of water samples. Results showed that whether or not there is an initial lag period in the oxidation of carbonaceous matter, the experimental results conform to the autocatalytic model and that if the size of inocula and the microbial activities increase adequately, the model can be converted into a first-order kinetics equation. (Geiger-PTT)
W91-04038

EFFICIENCY OF ROTATING BIOLOGICAL CONTACTOR IN REMOVING PATHOGENIC BACTERIA FROM DOMESTIC SEWAGE.

Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
M. Sagy, and Y. Kott.

Water Research WATRAG, Vol. 24, No. 9, p 1125-1128, September 1990. 5 fig, 1 tab, 21 ref.

Descriptors: *Biological wastewater treatment, *Coliforms, *Domestic wastes, *Municipal wastewater, *Salmonella, *Wastewater treatment, Bacteria, Biochemical oxygen demand, Fecal coliforms, Separation techniques.

Fecal coliform bacteria and Salmonella typhimurium die-off were examined in an experimental rotating biological contactor which received settled domestic sewage from a city main sewer. During the four seasons of the year, pH of effluents was always 8.0. Dissolved oxygen was always present in the bath compartment and although influent BOD5 fluctuated between 70-250 mg/L, the effluent BOD5 was about 10 mg/L. Varying hydraulic loads did not influence the number of coliform or fecal coliform bacterial numbers. There was a significant difference in survival of fecal coliform placed in dialysis bags attached to the rotating disks (drum) and to those submerged in the bath; the latter died much more slowly. When the dialysis bags containing S. typhimurium were placed in the bath, the bags that did not contain algae (diatoms and Oscillatoria), showed slower die-offs which were one order of magnitude within 1 day, compared to more than two orders of magnitude in bags that contained the algae. It is assumed that rotating biological contactors are very efficient in removing pathogenic bacteria found in domestic sewage. (Author's abstract)
W91-04042

EFFECTS OF PH AND OXIDATION STATE OF CHROMIUM ON THE BEHAVIOR OF CHROMIUM IN THE ACTIVATED SLUDGE PROCESS.

National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div.
A. Imai, and E. F. Gloyna.

Water Research WATRAG, Vol. 24, No. 9, p 1143-1150, September 1990. 8 fig, 2 tab, 23 ref.

Descriptors: *Activated sludge process, *Chromium, *Hydrogen ion concentration, *Oxidation, *Wastewater treatment, Adsorption, Separation techniques.

The behavior of chromium (Cr) in the activated sludge process was evaluated in laboratory-scale, fill-and-draw activated sludge experiments. Both pH and the oxidation state of chromium were confirmed as critical parameters in the activated sludge process for evaluating the behavior of chromium. More than 55% of chromium was removed when trivalent chromium (Cr(III)) was introduced into the influent while less than 60% was removed when hexavalent chromium (Cr(VI)) was added over a pH range from 5 to 9. As pH was increased, the removal increased when Cr(III) was introduced but the reverse occurred with Cr(VI). Introduction of Cr(VI) into the influent resulted in less than 80% of chromium associated with solids; however, with Cr(III), more than 90% of chromium was bound with solids. These results suggest that the activated sludge process is capable of controlling the transport of Cr(III) to the environment but such is not the case for Cr(VI). Theoretical consideration based on thermodynamics predicted that no reduction of Cr(VI) to Cr(III) should occur and the only redox reaction should be the oxidation of Cr(III) to Cr(VI). However, no oxidation of Cr(III) to Cr(VI) was observed; some Cr(VI) was reduced to Cr(III). Kinetic constraints may have impeded the oxidation of Cr(III). Under the conditions of this study, Cr(III) may have been removed through adsorption rather than precipitation as Cr(OH)3. Cr(VI) might be adsorbed on the bacterial surface through specific adsorption. (Author's abstract)
W91-04045

INFLUENCE OF PHOSPHORUS ON GROWTH AND NUTRIENT STORAGE BY WATER HYACINTH (EICHHORNIA CRASSIPES (MART.) SOLMS) PLANTS.

Florida Univ., Gainesville. Dept. of Soil Science.
K. R. Reddy, M. Agami, and J. C. Tucker.

Aquatic Botany AQBODS, Vol. 37, No. 4, p 355-365, September 1990. 7 fig, 2 tab, 27 ref.

Descriptors: *Lake restoration, *Limnology, *Nutrients, *Phosphorus, *Plant growth, *Wastewater treatment, *Water hyacinth, *Water treatment, Aquatic plants, Aquatic productivity, Biomass, Nitrogen, Potassium.

The net productivity and nutrient (phosphorus (P), Nitrogen (N), and potassium (K)) uptake and storage by water hyacinth (Eichhornia crassipes) were evaluated at potassium concentrations of 0.06, 0.26, 0.56, 1.06, 2.56, and 10.06 milligrams potassium per liter in the culture medium, using 1000-liter outdoor tanks with a surface area of 1.7 square meters. Biomass yield increased with an increase of potassium up to 1.06 milligrams per liter, but higher concentrations did not increase biomass yield. Phosphorus storage by water hyacinth increased and decreased in response to potassium concentrations in the water. Maximum net productivity was measured at a plant tissue potassium content of 4.3 milligrams potassium per gram. Further increase in tissue potassium did not increase productivity. Plant density affected potassium storage in the tissue. When water hyacinth plants were cultured at a low potassium concentration (0.06 milligrams per liter), plant tissue potassium decreased by 50% within the first week of growth. Nitrogen and potassium storage in plant tissue increased with potassium supply of up to 2.56 and 1.06 milligrams potassium per liter in the culture medium, repectively. (Author's abstract)
W91-04052

ERROR ANALYSIS OF LIMITING-CASE SOLUTIONS TO THE STEADY-STATE-BIOFILM MODEL.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
P. B. Saez, and B. E. Rittmann.

Water Research WATRAG, Vol. 24, No. 10, p 1181-1185, October 1990. 1 fig, 2 tab, 13 ref. NSF grant ECE-83-51841.

Descriptors: *Biofilms, *Growth kinetics, *Limnology, *Mathematical models, *Wastewater treatment, Computers, Growth, Kinetics, Microorganisms, Model studies.

Although mechanistic biofilm-kinetic modeling has been advanced by the work of many groups and is becoming a mature discipline, it is not widely used for practical process analysis and design. One of the difficulties of using mechanistic biofilm models for estimating substrate flux is that closed analytical solutions are not available unless simplifying assumptions are made. Imposition of simplifying assumptions can cause errors in the computation of the substrate flux. Simple analytical solutions for the limiting cases of deep, fully penetrated, first-order and zero-order biofilms were evaluated for accuracy by comparison with the full solution of the steady-state-biofilm model. The fundamental dimensionless parameter Smin (it describes the relative growth potential of the microorganisms within a given system) was critical to the evaluation. Deep solutions were accurate when Ss (substrate concentration at the liquid/biofilm interface divided by the half-maximum-rate concentration) divided by the relative growth potential of the microorganisms within the system is large enough, but fully penetrated solutions rarely were accurate. First-order solutions were accurate when the relative growth potential of the microorganisms (Smin) was less than about 0.003 and zero-order solutions were accurate when Smin was greater than about 100. Most of the expected range of the relative growth potential of the microorganisms was accurately represented only by the full solution, unless Ss (substrate concentration at the liquid/biofilm interface divided by the half-maximum-rate concentration) divided by the relative growth potential of the microorganisms (Smin) was significantly greater than 1.0. This analysis emphasizes that the limiting-case solutions have restrictive ranges of applicability for steady-state biofilms. (Mertz-PTT)
W91-04071

ADSORPTION ISOTHERMS: ILLUSIVE CAPACITY AND ROLE OF OXYGEN.

Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
R. D. Vidic, M. T. Suidan, U. K. Traegner, and G. F. Nakhla.

Water Research WATRAG, Vol. 24, No. 10, p 1187-1195, October 1990. 6 fig, 4 tab, 17 ref.

Descriptors: *Adsorption, *Anaerobic conditions, *Granular activated carbon, *Organic pollutants, *Water treatment, Aerobic conditions, Chemical reactions, Cresol, Degradation, Organic compounds, Oxygen, Phenols, Water pollution treatment.

Granular activated carbon is widely used in both water and wastewater treatment as an adsorbent for the removal of organic pollutants. One of the key components needed for the scale-up of experimental data and for the prediction of adsorber performance is the capacity of granular activated carbon for the retention of organic compound. The influence of molecular oxygen on the adsorptive capacity of granular activated carbon was examined. A new experimental procedure for determining adsorption isotherms was introduced. This procedure, denoted as anaerobic, differs from the currently used techniques, denoted as aerobic in that oxygen was repeatedly purged from the test environment. Results showed that the capacity of granular activated carbon for the retention of 0-cresol could increase up to 3-fold in the presence of oxygen when compared to the anaerobic capacity. The same trend was observed for the adsorption of phenol and 3-ethylphenol. It was shown that this increase in capacity could not be attributed to biological degradation of these adsorbates in the presence of oxygen. It was speculated that this phenomenon was due to chemical reactions between the adsorbates and molecular oxygen that were catalyzed by the activated carbon surface and occurred at a different time scale than physical adsorption. Initial portions of breakthrough curves for 0-cresol were very accurately predicted using capacities depicted by the anaerobic isotherm, while the total granular activated carbon adsorptive capacity for 0-cresol, as determined from breakthrough experiments, appeared to agree closely with the capacity predicted from the aerobic isotherm. (Mertz-PTT)
W91-04072

OPTIMAL CONTROL OF THE ACTIVATED SLUDGE PROCESS.

Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
J. C. Kabouris, and A. P. Georgakakos.

Water Research WATRAG, Vol. 24, No. 10, p 1197-1208, October 1990. 6 fig, 2 tab, 44 ref, append.

Descriptors: *Activated sludge process, *Computer models, *Waste load allocation, *Wastewater treatment, Advanced wastewater treatment, Biological treatment, Biological wastewater treatment, Case studies, Simulation, Sludge treatment, Suspended solids, Waste load, Wastewater management.

The high variability of the influent waste load necessitates control actions to prevent process failure and preserve treatment efficiency. The process can be regulated by varying certain inputs such as the wastewater feed point, sludge recycle and wastage rates, aeration rate and on-line sludge storage and resupply rates. Application of modern optimal control theory techniques in the regulation of the activated sludge process was explored. The process was simulated using multicomponent biological reactor and dynamic thickening models. The control problem was formulated with recycle and wastage rates as control variables and was characterized by high dimensionality and system model nonlinearity. The solution was obtained

using a Newton-type successive approximations control method. In case study, wastewater stream and sludge recycle flow entered a 250 cubic meter biological reactor for biological oxidation of the substrate. A portion of the biological reactor outflow, equal to the sludge recycle rate, entered the upper thickener layer while the remaining portion was discharged as effluent. The assumption was that no solids escaped with the effluent. In the case study, the new control approach was compared with the commonly proposed recycle ratio control strategy, and a constant recycle and wastage rate strategy. Wastage regulation was shown to be a much more effective control input than recycle for reducing effluent organic variability. The control framework proposed could be extended to include other regulation schemes and account for process and input uncertainties. (Mertz-PTT)
W91-04073

MICROBIAL REGENERATION PROCESS FOR GRANULAR ACTIVATED CARBON--I. PROCESS MODELLING.
Waterloo Univ. (Ontario). Dept. of Chemical Engineering.
D. H. Hutchinson, and C. W. Robinson.
Water Research WATRAG, Vol. 24, No. 10, p 1209-1215, October 1990. 2 fig, 31 ref.

Descriptors: *Activated carbon, *Biological treatment, *Carbon regeneration, *Industrial wastewater, *Wastewater treatment, Adsorption, Filter media, Granular activated carbon, Kinetics, Microorganisms, Model studies, Regeneration, Water treatment.

Biological regeneration is one of several processes that have been used to recover the adsorptive capacity of spent activated carbon. Carbon is regenerated biologically by contacting the spent carbon with a microbial population that is capable of metabolizing the adsorbed species subsequent to their desorption from the carbon into the fermentation broth. The dynamics of the in situ regeneration of both a single-solute and a bisolute granular fixed-bed activated carbon adsorber was examined. A detailed model of both the adsorption and the bioregeneration parts of the overall sequential process was developed which included a description of the microbial degradation kinetics, adsorption/desorption equilibrium, intraparticle mass transfer and solute diffusion through the external liquid film. Plug flow of liquid through the activated carbon bed was assumed. The method orthogonal collocation was successfully applied in obtaining a numerical solution of the adsorption/desorption-bioregeneration model. The adsorption/desorption-bioregeneration model can be used to predict the breakthrough behavior of both fresh and bioregenerated carbon. The breakthough behavior of a bioregenerated activated carbon adsorber is the most relevant measure of the performance of the bioregeneration process. (See also W91-04075) (Mertz-PTT)
W91-04074

MICROBIAL REGENERATION PROCESS FOR GRANULAR ACTIVATED CARBON--II. REGENERATION STUDIES.
Waterloo Univ. (Ontario). Dept. of Chemical Engineering.
D. H. Hutchinson, and C. W. Robinson.
Water Research WATRAG, Vol. 24, No. 10, p 1217-1223, October 1990. 8 fig, 4 tab, 11 ref.

Descriptors: *Activated carbon, *Biological treatment, *Carbon regeneration, *Pseudomonas, *Wastewater treatment, *Water treatment, Filter media, Microorganisms, Model studies, Regeneration.

The in situ biological regeneration of an activated carbon adsorber was investigated using a single-solute system containing phenol and a bisolute system containing phenol and p-cresol. Both were regenerated using a mono-culture of Pseudomonas putida. The performance of an activated carbon adsorber that was bioregenerated up to six times was evaluated on the basis of the breakthrough of phenolics during each intervening continuous-flow adsorption period. For both the regeneration and the loading cycles, predictions of system behavior based on a previously developed bioregeneration model agreed well with experimental observations. Carbon particle internal diffusion resistances were found to be rate limiting during most of the regeneration cycle. The breakthrough performance of the bioregenerated carbon was found to deteriorate with each successive regeneration. Microbial fouling of the column during bioregeneration was found to produce a marked deterioration in the subsequent breakthrough performance of the bioregenerated activated carbon. (See also W91-04075) (Author's abstract)
W91-04075

IMPLICATIONS OF THE TASK GROUP MODEL--I. THE EFFECT OF INITIAL SUBSTRATE CONCENTRATION.
Technical Univ. of Istanbul (Turkey). Div. of Environmental Sciences.
N. Artan, D. Orhon, and B. B. Baykal.
Water Research WATRAG, Vol. 24, No. 10, p 1251-1258, October 1990. 8 fig, 3 tab, 29 ref.

Descriptors: *Activated sludge process, *Model studies, *Simulation analysis, *Wastewater treatment, Activated sludge, Biological treatment, Biological wastewater treatment, Chemical oxygen demand, Computer models, Microorganisms, Sludge treatment.

The complexity of wastewaters often imposes the use of non-specific parameters, such as chemical oxygen demand, as measures of the available substrate for biological treatment. The merit of the task group model to reflect the effect of the initial substrate concentration on the performance of microbial systems was assessed in terms of the effluent soluble chemical oxygen demand. In this context, a structural modification is proposed to account for this effect, by incorporating mechanisms responsible for the generation of soluble microbial products considered residual for the particular operating conditions of the activated sludge systems. Model simulations of a number of practically significant scenarios were performed and evaluated for a continuous activated sludge reactor with sludge recycle. Reasonably good agreement was depicted between the model outputs and experimental data from previous studies. The generation of soluble residual products was a required consideration for the evaluation of the effect of initial substrate concentration on the effluent chemical oxygen demand. While the proposed model provides an acceptable starting point for this concept, it also underlines the need for further research and experimental evidence to better understand the problem. (See also W91-04081) (Mertz-PTT)
W91-04080

IMPLICATIONS OF THE TASK GROUP MODEL--II. RESPONSE TO INTERMITTENT LOADINGS.
Technical Univ. of Istanbul (Turkey). Div. of Environmental Sciences.
B. B. Baykal, D. Orhon, and N. Artan.
Water Research WATRAG, Vol. 24, No. 10, p 1259-1268, October 1990. 9 fig, 4 tab, 20 ref.

Descriptors: *Activated sludge process, *Model studies, *Pollution load, *Wastewater treatment, Activated sludge, Biodegradation, Biological treatment, Biological wastewater treatment, Biomass, Mathematical models, Sludge treatment.

A new modeling approach was recently proposed which is expected to offer a significant advantage over the classical activated sludge models. Basically, the model categorizes the substrate as soluble and particulate and further classifies it as readily biodegradable, slowly biodegradable and inert. It also makes use of the active biomass/viability concept and adopts the death/regeneration approach as it differentiates viable biomass from slowly biodegradable and inert particulate matter. The incorporation of a mechanism for the generation of residual soluble substrate enables the model to account for earlier statements that effluent substrate does not have the same character as the influent. The behavior of activated sludge systems subject to intermittent loadings was explored using the task group model modified for soluble residual product formation. The modified task group model included five main process components, two of which (readily biodegradable soluble substrate and residual soluble substrate) relate to soluble components, while active biomass, slowly biodegradable particulate substrate and inert particulate organics, define particulate components. A number of model simulations were performed to reflect system behavior under starvation, recovery after no feed periods, and the effect of various intermittent loadings on model components. The modified model appears to provide a rational framework to analyze and evaluate the behavior of activated sludge systems under intermittent loadings. (See also W91-04080) (Mertz-PTT)
W91-04081

AUTOMATED MAPPING FOR ALABAMA SEWER SYSTEM.
BCM Engineers, Mobile, AL.
W. Roberson, and R. Mastrangelo.
Public Works PUWOAH, Vol. 121, No. 12, p 53-54, November 1990. 1 fig.

Descriptors: *Alabama, *Computer programs, *Digital map data, *Mapping, *Public utility districts, *Sewer systems, Automation, Cost-benefit analysis, Databases, Geographic information systems, Sewer districts, Storm sewers.

As the demand for automated utility mapping has grown, software manufacturers have responded with Geographic Information Systems (GIS). Yet these generic software packages are neither specific nor user-friendly. Opelika, Alabama, requested a menu-driven system that would address the city's particular needs for automated sanitary and storm sewer mapping systems from the outset. A system was designed using commercially available hardware and software. For the initial project, a series of 52 aerial photographs were digitized as base maps and converted to templates. Customized menus were used to control and enhance the input of the map data, allowing support staff to update an external database program. Each manhole was assigned a unique identification number which identifies the rim elevation, invert, diameter, construction material, and inspection reports. Among other program capabilities is the automatic calculator, which tracks total sewer line lengths. A second project compiled a complete inventory of Opelika's storm sewer system, digitized by customized software programs from detailed field observations. The entire digitized mapping system for Opelika was very cost-effective: digitizing base maps and developing a database for the sanitary sewer system was completed at an approximate cost of $65,000; inventory and mapping of the stormwater system was completed for an additional $35,000; CADD hardware/software cost $15,000 to $20,000. Once the groundwork of digitized base mapping is laid, the cost of overlaying each additional system decreases while the possibilities for expansion are almost limitless. (Fish-PTT)
W91-04116

MONITORING LINEAR ALKYL BENZENE SULFONATE IN THE ENVIRONMENT: 1973-1986.
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
For primary bibliographic entry see Field 5B.
W91-04143

CHLOROACETONES IN PULP MILL CHLORINATION-STAGE EFFLUENTS.
CanSyn Chemical Corp., Toronto (Ontario).
For primary bibliographic entry see Field 5B.
W91-04150

BIOSORPTION OF RADIONUCLIDES BY FUNGAL BIOMASS.
Dundee Univ. (Scotland). Dept. of Biological Sciences.
C. White, and G. M. Gadd.
Journal of Chemical Technology and Biotechnol-

ogy JCTBDC, Vol. 49, No. 4, p 331-343, 1990. 6 fig, 36 ref.

Descriptors: *Biological wastewater treatment, *Bioreactors, *Fungi, *Radioisotopes, *Thorium, *Wastewater treatment, Biomass, Biosorption, Radioactive waste disposal.

Four kinds of bioreactors were evaluated for thorium removal by fungal biomass. Static-bed or stirred-bed bioreactors did not give satisfactory thorium removal probably because of poor mixing. An air-lift bioreactor removed approximately 90-95% of the thorium supplied over extended time periods and exhibited a well-defined breakthrough point after biosorbent saturation. The air-lift bioreactor promoted efficient circulation and effective contact between the thorium solution and the mycelial pellets. Of several fungal species tested, Rhizopus arrhizus and Aspergillus niger were the most effective biosorbents with loading capacities of 0.5 and 0.6 mmol/g, respectively (116 and 138 mg/g) at an inflow thorium concentration of 3 mm/cu dm. The efficiency of thorium biosorption by A. niger was markedly reduced in the presence of other inorganic solutes while thorium biosorption by R. arrhizus was relatively unaffected. Air-lift bioreactors containing R. arrhizus biomass could effectively remove thorium from acidic solution (1 mol/cu dm of nitric acid) over a wide range of initial thorium concentrations (0.1-3 mmol/cu dm). It was concluded that biosorption using fungal biomass is a technically feasible method for the removal of thorium from acidic solutions similar to those encountered in industrial process streams. (Author's abstract)
W91-04156

RECOVERY OF METAL IONS BY MICROFUNGAL FILTERS.
British Textile Technology Group, Manchester (England).
D. S. Wales, and B. F. Sagar.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 49, No. 4, p 345-355, 1990. 4 fig, 6 tab, 10 ref.

Descriptors: *Biofiltration, *Biological wastewater treatment, *Fungi, *Heavy metals, *Metals, *Wastewater treatment, Biosorption, Cadmium, Chitin, Chromium, Cobalt, Copper, Iron, Lead, Metal recovery, Nickel, Silver, Zinc.

Many microfungi contain chitin/chitosan as an integral part of the cell wall structure. The binding of toxic and heavy metal ions by chitosan or partly deacetylated chitin is a direct consequence of the base strength of the primary amine group and is most effective for those metals that form complexes with ammonia. Of the microfungi studied, hyphae from Mucor mucedo and Rhizomucor miehei, after treatment with hydroxide to expose the chitin/chitosan, were found to be most effective in the capture of metal ions. Chemically treated mycelia have so far been shown to bind silver, zinc, lead, copper, nickel, cobalt, cadmium, iron and chromium, with the efficiency of metal-ion binding apparently being inversely proportional to the valency state of the metal ions to be bound. Wet-laid papers produced from mixed slurries of treated mycelia and various conventional papermaking and textile fibers have exceptionally good tensile and bursting strength properties, particularly in the wet state. Papers containing 1 g of treated mycelia removed up to 90% of various metal ions in solution (50 cc, 1.5 mmol/cu dm) with flow rates of 0.5 cc/sq cm/min. However, the total metal-ion binding capacities of single-thickness microfungal papers are limited under constant flow conditions. The total volume flowing through the system before metal ion breakthrough occurs increases in direct proportion to the number of sheets of microfungal paper but the concomitant reduction in flow rates becomes a limiting factor. Mycelia-containing structures that allow efficient metal ion binding at commercially acceptable flow rates are currently being investigated. (Author's abstract)
W91-04157

IMMOBILIZED CELL BIOPROCESS FOR THE REMOVAL OF HEAVY METALS FROM AQUEOUS FLOWS.
Oxford Univ. (England). Dept. of Biochemistry.
L. E. Macaskie.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 49, No. 4, p 357-379, 1990. 9 fig, 14 tab, 37 ref.

Descriptors: *Biofilm reactors, *Biological wastewater treatment, *Heavy metals, *Microorganisms, *Waste treatment, *Wastewater treatment, Citrobacter, Enzymes, Immobilized cells, Phosphatases.

A bioprocess for the uptake of heavy metals from liquid wastes which could be applied to large-scale systems was described and defined in mathematical terms. During growth of a Citrobacter sp., cells overproduce an atypically metal-resistant phosphatase which continues to function in growth-decoupled, 'resting' cells to liberate phosphate from organic molecules. The phosphate precipitates stoichiometrically with added heavy metals as a cell-bound complex. Using pre-grown biomass immobilized in a flow-through filter (bioreactor), the metal-accumulative bioprocess, which requires no further cell growth, can be described accurately applying traditional Michaelis-Menton kinetics. Since heavy metal phosphates are generally highly insoluble, no metal specificity was shown and in all cases tested metal removal was generally in excess of 90% of that presented. Preliminary results indicated that polyacrylamide gel-immobilized and biofilm-immobilized cells performed identically in terms of phosphate liberation and metal uptake. A survey of commonly used supports for large-scale processes identified polyurethane reticulated foam as giving promising results. A working system for bioreactor modeling was developed and found to accurately predict experimental results. (MacKeen-PTT)
W91-04158

REVIEW OF BIOTECHNOLOGY APPLICATIONS TO NUCLEAR WASTE TREATMENT.
PA Consulting Group--Technology, Cambridge Laboratory, Melbourn, Royston, Hertfordshire SG8 6DP, England.
For primary bibliographic entry see Field 5E.
W91-04159

METAL RECOVERY USING CHITOSAN.
Protan A/S, Drammen (Norway).
E. Onsoyen, and O. Skaugrud.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 49, No. 4, p 395-404, 1990. 7 fig, 2 tab, 29 ref.

Descriptors: *Chitosan, *Heavy metals, *Wastewater treatment, *Water treatment, Biopolymers, Chelating agents, Metal recovery, Potable water.

Chitosan is a natural polycationic polymer which possesses valuable properties as a metal recovering and water purifying agent. Applications include: (1) wastewater treatment for heavy metal and radioisotope removal and valuable metal recovery; (2) potable water purification for reduction of unwanted metals; (3) in agriculture, for the controlled release of trace metals essential to plant growth; and (4) food, for the complex binding of iron in precooked food to reduce 'warmed-over flavor'. The interactions of metals with chitosan are complex, probably simultaneously dominated by adsorption, ion-exchange and chelation. Use of well characterized chitosans in the study of chitosan-metal interactions is recommended, although characterizing methodology is limited. Degree of polymerization and deacetylation and the distribution of acetyl groups along the polymer chain is of crucial importance for chitosan-metal binding characteristics. Chemical derivatization has been used to alter the metal interacting characteristics of chitosan. Chitosan possesses general coagulant/flocculent characteristics towards biomolecules and surfaces. (Author's abstract)
W91-04160

COSTS OF WASTEWATER USE IN THE TUCSON BASIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 6C.
W91-04195

TREATED MUNICIPAL SEWAGE EFFLUENT AS A SOURCE OF POWER PLANT COOLING TOWER MAKEUP WATER.
Water Reclamation Facility, Phoenix, AZ.
D. E. Blackson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 571-580, 4 fig, 2 tab, 3 ref.

Descriptors: *Cooling water, *Industrial water, *Wastewater treatment, *Wastewater utilization, *Water conservation, *Water reuse, *Water use data, Municipal wastewater, Nuclear powerplants, Powerplants, Wastewater renovation.

The Water Reclamation Plant (WRP) processes treated municipal sewage effluent to produce cooling tower makeup water for the Palo Verde Nuclear Generating Station. The WRP is an advanced wastewater treatment plant that receives effluent from the Phoenix 91st Avenue and Tolleson Wastewater Treatment Plants. The wastewater goes through a multistage biochemical treatment process. First, trickling filters remove ammonia and reduce alkalinity. Next, the effluent enters first stage solids contact clarifiers where lime slurry is added. Phosphate, magnesium, silica and some calcium are removed. The effluent then flows to second stage solids contact clarifiers where soda ash and carbon dioxide gas are added. Calcium carbonate is precipitated. The effluent is filtered by a dual media gravity filter and conveyed to a storage reservoir. The reservoir can store up to 670 million gallons. Water is pumped from the reservoir to the cooling towers upon demand. The successful operation of the WRP demonstrates that reuse of municipal sewage effluent for powerplant cooling tower makeup is a feasible alternative to groundwater or surface water for this application. (See also W91-04161) (Author's abstract)
W91-04221

MICROBIAL DISSOLUTION AND STABILIZATION OF TOXIC METALS AND RADIONUCLIDES IN MIXED WASTES.
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
For primary bibliographic entry see Field 5E.
W91-04264

CAPILLARY ZONE ELECTROPHORETIC SEPARATION OF CHLOROPHENOLS IN INDUSTRIAL WASTE WATER WITH ON-COLUMN ELECTROCHEMICAL DETECTION.
Anamed Instruments Ltd., Bombay (India). Applictions and Methods Development Lab.
For primary bibliographic entry see Field 5A.
W91-04266

WATER ROUND ROBIN FOR PARTS-PER-QUADRILLION DETERMINATION OF PCDDS AND PCDFS.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
C. Tashiro, R. E. Clement, S. Davies, B. Oliver, and T. Munshaw.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1313-1317, 1990. 4 tab, 4 ref.

Descriptors: *Analytical techniques, *Data quality control, *Dioxins, *Furans, *Halogenated compounds, *Pollutant identification, *Round-robin tests, *Wastewater analysis, *Water analysis, Chemical analysis, Chemical industry, Comparison studies, Detection limits, Effluents, Gas chromatography, Industrial wastewater, Mass spectrometry, Municipal wastewater, Oil industry, Ontario, Performance evaluation, Precision, Pulp and paper industry, Quality control, Steel industry, Water quality.

The provincial Municipal Industrial Strategy for Abatement (MISA) is an Ontario Ministry of Environment (MOE) program that is currently being carried out to monitor contaminants from the following sources: (1) municipal effluents; and discharges from the (2) pulp and paper, (3) iron and steel, (4) petroleum, and (5) organic chemical industries. Chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) are included in the monitoring program. To determine the CDD/CDF MISA method detection limits achievable by experienced laboratories for 4.0 L effluents, a round robin was carried out by private labs and by the MOE Dioxin Lab spiked blank water samples. Based on the precision estimates of the individual laboratories, MISA laboratory method detection limits (MISA-MDL) were calculated. The MISA-MDL values ranged from 15 ppq to 30 ppq for 4.0 L water samples and should be obtainable using single quadrupole gas chromatography/mass spectrometry in the selected ion monitoring mode. The overall performance of the laboratories was variable which indicates that further quality assurance/quality control protocols may be required in the MISA guidelines. Method detection limits for real effluent samples will be determined in a future round robin. (Korn-PTT)
W91-04279

PCDDS AND PCDFS IN WATER, SLUDGE AND AIR SAMPLES FROM VARIOUS LEVELS IN A WASTE WATER TREATMENT PLANT WITH RESPECT TO COMPOSITION CHANGES AND TOTAL FLUX.
Stockholm Univ. (Sweden). Dept. of Analytical Chemistry.
C. Naf, D. Broman, R. Ishaq, and Y. Zebuhr.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1503-1510, 1990. 5 fig, 1 tab, 12 ref.

Descriptors: *Air analysis, *Dioxins, *Furans, *Halogenated compounds, *Sludge analysis, *Wastewater facilities, *Water analysis, Fertilization, Industrial wastewater, Land disposal, Municipal wastewater, Particulate matter, Polychlorinated dibenzofurans, Sludge disposal, Storm sewers, Sweden, Urban runoff.

The presence of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in digested sludge has been a question of great concern during the past years mainly because sludge is distributed on farm land as fertilizer. An estimate was made of the annual flow of PCDDs and PCDFs through a Swedish wastewater treatment plant. The samples were collected from different steps in the treatment procedure within the plant (e.g., inlet and outlet water, different sludge types, air samples). Samples were also collected from areas surrounding the plant, including urban air, storm sewer water (urban runoff), plant discharge water, and particulates from a sediment trap downstream of the plant discharge. All samples were analyzed using gas chromatography/mass spectrometry (GC/MS). Differences in congener profiles were found between the samples taken within the plant and those collected outside. This may be indicative of a greater contribution of the toxic isomers in samples closer to the sources (i.e., urban air and storm sewer water). However, it may also indicate a different composition in the storm sewer water compared to the domestic and industrial wastewater which constitute the major part of the combined inlet water. The flux of PCDD and PCDF equivalents through the plant was found to be approximately 0.4-0.5 g/year and the major part was taken away as digested sludge. (Author's abstract)
W91-04293

TREATMENT OF GELATINE FACTORY EFFLUENT.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
J. P. Maree, C. G. B. Cole, A. Gerber, and J. L. Barnard.
Water SA WASADV, Vol. 16, No. 4, p 265-268, October 1990. 1 fig, 2 tab, 8 ref.

Descriptors: *Biological wastewater treatment, *Effluents, *Industrial wastewater, *Wastewater treatment, Anaerobic digestion, Calcium carbonate, Chemical oxygen demand, Combined treatment, Gelatin effluents, Hydrogen ion concentration, Lime, Primary wastewater treatment, Secondary wastewater treatment.

In the process of gelatin manufacture, bovine hide is soaked for several months in lime pits. The pit effluents are high in pH, chemical oxygen demand (COD) and calcium content and constitute a major source of pollution. Two process configurations were evaluated for treatment of the effluent, anaerobic treatment and combined anaerobic-aerobic treatment. For the combined treatment, water was used to dilute the raw water by 58%. Calcium carbonate which precipitated during treatment served as a medium on which bacterial growth could occur in the primary anaerobic stage. Ceramic Raschig rings were used as immobilization medium in the aerobic biofilter and activated carbon in the secondary anaerobic stages. Insoluble organic and solubilized and complex organic molecules were biodegraded to simpler molecules through hydrolytic reactions in the primary anaerobic stage. The molecules produced were further fermented to short-chain volatile acids, resulting in the pH of the water being reduced from 12.0 to 8.1, the COD reduced from 20,500 to 17,500 mg/L and calcium reduced from 5,210 to 1,680 mg/L (as calcium carbonate). Except for the initial period of the experiment (first 50 d), no methane production was achieved in the anaerobic reactor as a result of high concentrations of sulfide (1200 mg/L (as S)), ammonia (1800 mg/L (as N)) and propionic acid 1000 mg/L), and a pH of 7.9. In the aerobic and secondary anaerobic stage, organic acids were biodegraded to carbon dioxide, resulting in a further COD reduction to 6,000 mg/L and calcium reduction to 230 mg/L. It was concluded that the effluent can effectively be neutralized via biological treatment, resulting in a 95% removal of the effluent calcium and a 74% reduction of the COD value. (Author's abstract)
W91-04317

THERMODYNAMIC CONSIDERATIONS ON THE PERFORMANCE OF TWO-STAGED ANAEROBIC DIGESTERS.
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Microbiology.
T. J. Britz, and W. A. Joubert.
Water SA WASADV, Vol. 16, No. 4, p 269-274, October 1990. 3 fig, 1 tab, 15 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Stage digestion, *Thermodynamics, *Wastewater treatment, Energy sources, Fixed film, Metabolites, Methanogenesis, Organic acids, Sludge, Temperature effects.

An upflow acidogenic phase hybrid digester (combining a sludge blanket and fixed film) was sampled at different digester levels (200, 400, 600 and 800 ml) in order to evaluate thermodynamically the theoretical amount of energy of the metabolites present for use as substrate by the syntrophic methanogenic bacteria in a second digester. The distribution of metabolite concentrations along the digester axis was evaluated at different temperatures (29 to 40 C). The major metabolites detected were ethanol and acetic, propionic, n-butyric and n-caproic acids. Results showed that most of the metabolites were markedly influenced by changes in temperature and concentrations varied at the different digester levels. Calculations indicated that at a temperature of 35 C and at all digester levels the composition of metabolites in the effluent was optimal with respect to the thermodynamic energy theoretically available to the organisms in a second acetogenic/methanogenic stage. (Author's abstract)
W91-04318

BIOACCUMULATION OF SELECTED HEAVY METALS BY THE WATER FERN, AZOLLA FILICULOIDES LAM. IN A WETLAND ECOSYSTEM AFFECTED BY SEWAGE, MINE AND INDUSTRIAL POLLUTION.
Rand Afrikaans Univ., Johannesburg (South Africa). Dept. of Zoology.
For primary bibliographic entry see Field 5B.
W91-04320

MINIMISING LIQUID DISCHARGE FROM LARGE POWER PLANTS.
Eskom, Johannesburg (South Africa). Chemical Engineering and Chemistry Div.
J. D. Aspden, and D. A. Swanepoel.
Water SA WASADV, Vol. 16, No. 4, p 287-292, October 1990. 2 fig, 2 tab, 2 ref.

Descriptors: *Cooling water, *Desalination, *Electrodialysis, *Membrane processes, *Reverse osmosis, *Wastewater treatment, *Water reuse, Desalination plants, Lethabo Power Station, Powerplants, Salt rejection, South Africa, Total dissolved solids, Tutuka Power Station, Water management.

A water management program to maximize the use of water at Eskom power stations was described. With the advent of dry ash disposal and the resultant loss of an effluent sink, an alternative means of reuse and concentration of the cooling water blowdown had to be found. Pilot plant studies identified electrodialysis reversal (EDR) and tubular reverse osmosis (TRO) as the most promising methods from a number of membrane systems evaluated for the desalination step. Plant availability problems which occurred in Phase I of an EDR project at the 3600 MW Tutuka Power Station were remedied and current performance characteristics include 90% plant availability, 5434 cu m/d feed flow, total dissolved solids (TDS) concentration of 940 g/cu m in product, and 6085 kg/d salt load in product. A TRO project at the 3600 MW Lethabo Power Station had early performance characteristics of 181 g/cu m TDS in product, 86% salt rejection and sectionalized plant availability of 80%. Performance declined steadily with current characteristics of 740 g/cu m TDS in product, 63% salt rejection and sectionalized plant availability of 60%. Action plans have been developed to address the problems in availability and performance. At both power stations, the brine from the membrane systems is transferred to an evaporation plant for secondary concentration. It is concluded that the primary problems of both desalination systems have resulted in extended downtime at both sites. The benefits of the systems are elimination of point source pollution to public streams and reuse of water. (MacKeen-PTT)
W91-04321

COMPARISON OF OVERFLOWS FROM SEPARATE AND COMBINED SEWERS--QUANTITY AND QUALITY.
University of Technology Sydney, Broadway (Australia). School of Civil Engineering.
M. G. Carleton.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 31-38, 1990. 4 fig 3 tab, 6 ref.

Descriptors: *Combined sewers, *Overflow, *Separated sewers, *Sewer systems, *Storm water, *Urban runoff, *Wastewater disposal, *Water pollution control, *Water pollution sources, Australia, Combined sewer overflows, France, Rainfall impact, Storm runoff, Storm-overflow sewers, Urban hydrology, Water pollution effects.

Separate sewerage systems are frequently seen to be the solution to receiving water pollution problems associated with combined storm water sewerage systems. The main problem with combined systems is the regular overflows, which occur during or following storm events. A comparison was made of the operation of separate sewerage overflows (Australia) with combined system overflows (France). It was found that the operation of separate sewerage systems is similar to combined storm water sewer systems due to considerable storm inflows into the separate system. The annual frequencies and quality of overflows is similar. One major overflow event was recorded for both catchments for the one-year period. Annual pollutant loads from separate system overflows are higher than combined system overflows due to catchment and rainfall differences for both countries. The annual overflow durations for separate sewerage systems were found to be many times those for combined systems, indicating that sepa-

rate sewerage systems may be worse than combined systems. Differing rainfall characteristics undoubtedly caused more and longer overflows in Australia but equally, the considerable in-line storage capacity of the France system was found to prevent or significantly reduce overflows. The use of separate sewerage systems to solve the pollution problems associated with combined systems is questionable. Minimizing overflows was feasible, however proper and integrated control of storm water and sewage flows, related to receiving water impacts, is indicated as the best solution. The use of separate sewerage systems to solve pollution problems may not be justified. (Fish-PTT)
W91-04326

QUALITY OF SEWAGE FLOWS AND SEDIMENT IN DUNDEE.
Dundee Inst. of Tech. (Scotland). Dept. of Civil Engineering, Surveying and Building.
For primary bibliographic entry see Field 5B.
W91-04327

MICROBIAL ASPECTS OF SEWAGE AND SEWAGE SLUDGE IN DUNDEE, SCOTLAND.
Dundee Inst. of Tech. (Scotland). Dept. of Civil Engineering, Surveying and Building.
For primary bibliographic entry see Field 5B.
W91-04328

METAL SPECIATION IN SEPARATE STORMWATER SYSTEMS.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 5B.
W91-04329

DISTRIBUTION OF SEDIMENTATION RATES OF SUSPENDED SOLIDS AND HEAVY METALS IN COMBINED SEWER OVERFLOWS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
For primary bibliographic entry see Field 5B.
W91-04330

LONG-TERM SIMULATION OF POLLUTANT LOADS IN TREATMENT PLANT EFFLUENTS AND COMBINED SEWER OVERFLOWS.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
For primary bibliographic entry see Field 5B.
W91-04331

ESTIMATION OF STORM WATER QUALITY CHARACTERISTICS AND OVERFLOW LOADS FROM TREATMENT PLANT INFLUENT DATA.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
For primary bibliographic entry see Field 5B.
W91-04332

IMPROVED OVERFLOW IN A SEWERAGE SYSTEM AS A POLLUTANT LOAD-REDUCING DEVICE.
BKH Consulting Engineers, The Hague (Netherlands).
For primary bibliographic entry see Field 5G.
W91-04344

MONITORING A VORTEX STORM SEWAGE OVERFLOW WITH PERIPHERAL SPILL.
Sheffield City Polytechnic (England). School of Construction.
T. Cootes, D. J. Balmforth, S. Russell, and G. M. Doughty.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 189-195, 1990. 4 fig, 4 ref.

Descriptors: *Storm sewage, *Storm water management, *Storm-overflow sewers, *Urban runoff, Combined sewer overflows, Conveyance structures, Dissolved solids, England, Flow measurement, Hydraulic properties, Hydraulic structures, Performance evaluation, Suspended solids, Urban hydrology, Water pollution control.

Based on a design developed using model tests, a full-scale prototype of a vortex storm sewage overflow with peripheral spill has been built in Sheffield, England. A project is running to monitor this overflow in order to assess its performance, both hydraulically and qualitatively. Flows into and out of the overflow chamber are being recorded, and samples of sewage are being taken, both from the flow entering the overflow and that spilling to the watercourse. A system known as the 'Gross Solids Monitor' has been developed to get an estimate of the quantities of large objects in the flow, and examine how effective the overflow is at restraining such material from spilling. Due to equipment failures and little rain, only limited results have been gathered to date. These show that the overflow appears to exert good hydraulic control, but has little separating effect on fine suspended or dissolved material. Further data must be gathered before any conclusion can be reached as to how well the overflow restrains larger objects from spilling. Further work is required on the Gross Solids Monitor before data analysis becomes fully automated. (Author's abstract)
W91-04345

POLLUTANT REMOVAL AND EUTROPHICATION IN URBAN RUNOFF DETENTION PONDS.
Aalborg Universitetscenter (Denmark). Environmental Engineering Lab.
For primary bibliographic entry see Field 5G.
W91-04346

REDUCTION OF COMBINED SEWER OVERFLOW POLLUTION LOADS BY DETENTION OF SANITARY SEWAGE.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
W. Schilling, and D. T. Kollatsch.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 205-212, 1990. 4 fig, 1 tab, 7 ref.

Descriptors: *Combined sewer overflows, *Detention reservoirs, *Storm water management, *Urban runoff, *Water pollution control, Control systems, Diversion structures, Flow control, Germany, Hydrologic models, Operating policies, Risk assessment, Sewer systems, Storage tanks, Storm-overflow sewers.

For mixed combined/separate sewer systems it is proposed, in times of combined sewage overflows (CSO) to store sanitary sewage at the inlet point to the combined system. Thereby, sanitary sewage (with high strength) is kept in the system for further treatment after the storm, whereas less-polluted CSOs are diverted to the receiving water. Different scenarios were evaluated using an existing catchment to quantify the potential benefits of sanitary sewage detention. Comparison with current German CSO regulations shows that this approach is more effective than conventional CSO detention if more than 60% of the population upstream of the CSO diversion are served by a separate system. A key problem of this concept is the control strategy that determines when to activate and empty the storage tanks. A number of criteria were compared taking into account considerations on operational aspects such as chemical transformations in stored sewage, maximum allowable detention time, and cleansing of storage tanks. The contribution of combined sewer sediments to total overflow loads is especially relevant in low-gradient systems, and could not be controlled by a sanitary sewage detention tank (SST) at all. The SST control strategies ought to be simulated with inhomogeneous rain data to verify whether local measurements are sufficient for SST control. It might be worthwhile to use some simplified rainfall-runoff model to compute expected combined sewer flows at the downstream diversion and base SST control decisions on the computed flows. The question of operational risks should be answered by field tests. (Fish-PTT)
W91-04347

APPRAISAL OF CHANGES IN WATERCOURSE QUALITY AS A RESULT OF SEWER RECONSTRUCTION.
North West Water Authority, Warrington (England).
A. D. Parkinson, P. S. Davis, and A. J. Saul.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 213-221, 1990. 3 fig, 1 tab, 11 ref.

Descriptors: *Sewer systems, *Storm-overflow sewers, *Upgrading, *Urban runoff, *Water pollution control, Combined sewer overflows, Computer models, England, Flow discharge, Model studies, Performance evaluation, River systems, Storage tanks, Storm runoff, Storm water management.

Major sewerage work in Littleborough, in northwest England, resulted in the closure of eight combined sewer overflows and the construction of a new overflow incorporating downstream storage. The effect of the resewerage work on the River Roch is being studied as a collaborative exercise. The method known as the CARP (Comparative Acceptable River Pollution) procedure was used in setting the frequency and volume of discharge from the new overflow and, therefore, the size of the tank. The use of CARP to calculate the discharge flow during storm events resulted in a decrease in the size of the tank from 2800 cu m, using more conventional techniques, to 1500 cu m. First results indicate that this reduction is so far vindicated; however, the tank will not operate as frequently as predicted by other computer modeling. The discharge from the new combined sewer overflow would not appear to significantly affect the river, but should be confirmed by further field work. (Fish-PTT)
W91-04348

FYLDE COAST BATHING WATER IMPROVEMENTS--STORM WATER MANAGEMENT FOR COMPLIANCE WITH BATHING WATER DIRECTIVE.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5G.
W91-04349

CHARACTERIZATION OF SOLIDS TRANSFERRED INTO SEWER TRUNKS DURING WET WEATHER.
Centre d'Enseignement et de Recherche pour la Gestion des Ressources Naturelles et l'Environnement, Paris (France).
G. Chebbo, P. Musquere, V. Milisic, and A. Bachoc.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 231-238, 1990. 3 fig, 2 tab, 10 ref.

Descriptors: *Sediment transport, *Settleable solids, *Sewer systems, *Storm runoff, *Urban runoff, Combined sewers, Flow discharge, France, Hydrodynamics, Sediment analysis, Settling basins, Storm water, Suspended solids, Urban hydrology, Wastewater disposal.

A research program has been undertaken in France to gain a better understanding of the magnitude and variation of the polluting and hydrodynamic (particle size, vertical settling velocity, density, shape, etc.) characteristics of solids transferred during dry and wet weather. The intrinsic pollution, hydrodynamic, and flocculation and cohesiveness parameters of the solids were indexed, graded, and finally selected on the basis of bibliographical analysis. The parameters describing and explaining the accumulation and movement of the solids at the different levels of the urban water cycle relate to the atmosphere, the catchment area, the sewer network, the rainfall, and the climate. Different sampling methods and measurements were compared for a number of sites, including a 'reference' retention basin, a 'complementary' basin, a combined trunk sewer, a storm sewer, and gullies. The Bequigneaux retention basin was selected as an example of the methods used. Samples were collected of the storm water entering the basin, the solids settled during the storm event, and the waters during emptying. Some of the first results indicate that solids are the principal vector

of pollution in storm water and of wet weather discharge into waters of the natural environment. These solids are very fine with a dominant particle population of a few dozen micrometers; the relative size of this population appears to vary with the rainfall characteristics. Most of these solids settle readily. The collection, separation, and analysis of the solids will enable quantification of these findings more precisely. (Fish-PTT)
W91-04350

SEDIMENT IN SEWERS: INITIATION OF TRANSPORT.
Technische Hogeschool Delft (Netherlands). Dept. of Civil Engineering.
R. A. Kleijwegt, R. G. Veldkamp, and C. Nalluri.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 239-246, 1990. 4 fig, 2 tab, 8 ref.

Descriptors: *Path of pollutants, *Sediment transport, *Sewer hydraulics, *Sewer systems, *Storm runoff, *Urban hydrology, *Urban runoff, Bedload discharge, Cohesive sediments, Deposition, Flow discharge, Shear stress, Storm water, Storm-overflow sewers, Water pollution effects.

During storm events the discharge of pollutants in combined sewers is increased by the erosion of sediment deposits with adhered pollutants. Under these circumstances overflows will be highly influenced by the erosion processes in the sewers. In order to gain insight into the amounts of pollutants in overflows, the basic processes that are believed to be responsible were studied. The initiation of sediment transport in sewers was investigated in field and laboratory test studies; the field studies were concerned with the initiation of transport, while the laboratory studies deal with the determination of the boundary shear stress, incipient motion for both noncohesive and cohesive materials and the transport of sediment. From the field studies it was concluded that some deposits in sewers are permanent because of the insufficient capability of the flow to erode the deposits. Cementation of sand with organic matter intensifies the permanent character. The shear stress on the flat sediment bed is found to differ in the transverse direction. The predicted bed shear stresses (using the equations of motion and Einstein's separation technique) along the flat sediment bed compare reasonably well with the maximum measured (using velocity profiles) shear stresses. The theory was expected to be applicable in the calculation of the average bed shear stress, but appeared to be applicable in the calculation of the maximum bed shear stress. The upper limit of the critical shear stresses for cohesive sewer sediments may not exceed 5-7 N/sq m. Noncohesive sediments are eroded at lower shear stresses than predicted by Shields' criterion. Further studies to investigate the transport mechanisms of sediments are in progress. (Fish-PTT)
W91-04351

SEWER SEDIMENT AND ITS RELATION WITH THE QUALITY CHARACTERISTICS OF COMBINED SEWER FLOWS.
Universite Libre de Bruxelles (Belgium). Lab. de Traitement des Eaux et Pollution.
M. Verbanck.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 247-257, 1990. 8 fig, 3 tab, 20 ref.

Descriptors: *Combined sewers, *Sediment transport, *Sediments, *Sewer systems, *Storm water, *Urban hydrology, *Urban runoff, Belgium, Deposition, Hydraulic transportation, Main sewers, Organic matter, Particle size, Sand, Sediment analysis, Suspended solids.

Combined sewer lines in the center of Brussels, Belgium, are laid at very slack gradients, resulting during dry-weather in a systematic deficit of the load of particulate material at the outlet. The first results of a data collection program were evaluated with respect to the influence of in-sewer deposits upon pollution emissions. The monitoring of suspended solids load in the main trunk showed the extent of sediment deposition/resuspension processes in the system. Over a long period of time, the accumulation of deposits on sewer inverts is clearly noticeable. The total volume of deposition in the network also appears to be much more influenced by rainfall events than by human sewer-cleaning practices. Particle size analyses of sewer sediment samples have shown that most deposits in running sewers are composed of sandy material, which reduces the hydraulic capacity, but is suspected to have only slight adverse pollutional impact. Samples with finer material and higher organic contents were, however, found in some protected locations, not submitted to continuous dry-weather flow. From the experience gained in this study, it is strongly believed that the acquisition of detailed field data is essential in order to assess correctly the complex phenomena involved. (Author's abstract)
W91-04352

SEDIMENT MOVEMENT INTO THE COMBINED TRUNK SEWER NO. 13 IN MARSEILLE.
Centre National de la Recherche Scientifique, Toulouse (France). Inst. de Mecanique des Fluides.
D. Laplace, Y. Sanchez, D. Dartus, and A. Bachoc.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 259-266, 1990. 5 fig, 9 ref.

Descriptors: *Sediment transport, *Sewer systems, *Storm runoff, *Urban runoff, Combined sewers, Deposition, France, Main sewers, Particle size, Path of pollutants, Storm water management, Suspended solids, Urban hydrology.

Several studies both in France and in other countries have shown solids to be the main vector of pollution emanating from combined sewer overflows or from storm sewer discharges. A French technical organization (the AGHTM--General Association of Hygienists and Municipal Technicians) supports a research program on the transfer of solids into sewer networks, with the aim of better understanding how sediments develop in trunk sewers and what their contribution can be to wet-weather pollutant discharges. During the first phase, priority was given to observation, especially inside a combined trunk sewer in Marseille. Various parameters such as sediment depth, water level, flow velocity fields, sediment particle size, or mechanical characteristics were measured. Some conclusions have been reached, although the study is still underway. It was found that the volume of sediment increases substantially, principally at the entry points, during the first rainfall events; it decreased during the three days following rainfall, and seems to become stable after several months. The solids deposited in the sediment are much larger than those which make up the most part of pollutant discharge during wet weather. The first findings which lead directly from the observations and measurements already confirm the presence of certain classic phenomena, such as the natural particle size classification and the evolution of the sediment by progradation. (Fish-PTT)
W91-04353

COINCIDENT PROBABILITY OF GIVEN STORM WATER DISCHARGES IN URBAN SEWER SYSTEMS AND RECEIVING WATERS.
Kaiserslautern Univ. (Germany, F.R.). Fachgebiet Wasserbau und Wasserwirtschaft.
For primary bibliographic entry see Field 2E.
W91-04354

CONTINUOUS MONITORING OF WASTEWATER COMPOSITION IN SEWERS AND STORMWATER OVERFLOWS.
Universite Libre de Bruxelles (Belgium). Lab. de Traitement des Eaux et Pollution.
J.-P. Vanderborght, and P. Wollast.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 271-275, 1990. 4 fig.

Descriptors: *Automation, *Conductivity, *Instrumentation, *Monitoring, *Sensors, *Sewer systems, *Storm-overflow sewers, *Turbidity, *Wastewater analysis, Belgium, Combined sewer overflows, Flow measurement, Hydrologic data, Storm water, Urban runoff, Warning systems, Wastewater management, Water quality.

The city of Brussels is a highly urbanized area, so that any changes or additions to the existing combined sewer system are excessively expensive and involve considerable disturbances on all urban activities. In 1982, the State Secretary of the Brussels District initiated a major research on urban wastewater management, aimed at reducing the occurrence of floods and the discharge to the Senne river of grossly polluted storm water, without having to resort to new large wastewater collection or storage structures. Because of the dual nature of the objectives (a quantitative and qualitative management of the wastewater flow), it was felt that a real-time control of the system would have to incorporate not only quantitative data (flow measurements), but also qualitative information (composition of the wastewater). Such a system was developed and tested for its performance on a long-term basis. Conductivity and turbidity were selected for their ability to give information about the dissolved and suspended load in the wastewater flow. Nine wastewater monitors have been installed in the Brussels sewer system, and have been in continuous operation since 1984. The dry weather flow composition and about 100 rain and storm events have been recorded and transmitted to the data evaluation center. The specific monitoring device will unattendedly perform wastewater quality measurement without being plagued by plugging and fouling. A semi-continuous sampling with a minimum period of about 5 minutes will generally be adequate. Representative analysis can only be achieved on samples of a sufficient volume, on the order of 3 liters. The use of such devices as real-time sensors for the control of sewer systems can now be seriously considered. (Fish-PTT)
W91-04355

TRACER MEASUREMENTS OF REAERATION IN GRAVITY SEWERS.
Aalborg Universitetscenter (Denmark). Environmental Engineering Lab.
N. A. Jensen, and T. Hvitved-Jacobsen.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 279-282, 1990.3 fig, 1 tab, 5 ref.

Descriptors: *Aeration, *Oxygen, *Sewer systems, *Tracer studies, Denmark, Environmental tracers, Gravity flow, Krypton, Storm water, Tritium, Urban runoff, Wastewater composition, Wastewater disposal, Water pollution effects.

Until now little attention has been paid to investigating and evaluating the importance of wastewater transformations during transportation. In order to evaluate existing empirical equations for prediction of reaeration in gravity sewers, a tracer method was adapted for use in partly filled gravity sewers. Basically, the method involves the use of a gaseous tracer (krypton), Kr-85, with a gas transfer coefficient constant to that of oxygen under the conditions investigated, and a nongaseous dispersion tracer (tritium), H-3. By dosing the tracers at time t=0, the gas transfer coefficient of krypton is found, and the corresponding value for oxygen is found. Preliminary investigations were carried out in an intercepting sewer line in Denmark. Based on the results from the tracer measurements the reaeration coefficient was calculated. Furthermore, samples were taken in order to determine the wastewater characteristics, and the oxygen concentration in the sewer atmosphere was measured. These measurements resulted in values approximately 10% lower than under normal atmospheric conditions. Based on measurements under different flow conditions, it can be concluded that the developed tracer method results in values of the reaeration coefficient for gravity sewers with a high degree of accuracy. Further investigations will be carried out in order to evaluate the developed tracer method with the results from the empirical equations. (Fish-PTT)
W91-04357

SEDIMENT MOVEMENT IN COMBINED SEWERS IN DUNDEE.
Dundee Coll. of Technology (Scotland). Dept. of Civil Engineering.
M. J. Goodison, and R. M. Ashley.

Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 283-286, 1990. 3 fig, 7 ref.

Descriptors: *Combined sewers, *Scotland, *Sediment transport, *Sedimentation, *Sewer systems, *Storm water, *Urban hydrology, *Urban runoff, Cleaning, Economic aspects, Flood control, Flood forecasting, Flow models, Model studies, Simulation analysis, Suspended sediments.

An integrated program of work is now underway in Dundee, Scotland, to formulate engineering strategies to alleviate the flooding in the city center and also to minimize the continuing maintenance costs for sewer sediment removal. The objectives of this program are commensurate with current U.K. research initiatives which are investigating the nature and movement of sewer sediments and associated pollution. A study has been initiated to develop a long-term strategy to reduce the incidence of flooding by first constructing a flow simulation model of the city center sewerage system, incorporating programs of data collection to facilitate the development of simulation models of the sediment buildup, movement, and related pollution. The initial program began in 1986, and subsequent studies were implemented to study sediment provenance, movement, and quality in 1987 and 1988. In the U.K. some 10% of all sewers have permanent sediment deposits. Sewer cleaning expenditures in Dundee represent the cost of a relatively sediment-free sewer for a period of only three to six months. The data collected so far have shown a consistency in dry weather flow patterns for both flow and mass of suspended material. Further work planned in Dundee will provide data to assist in the development of new models for sewer flow quality. (Fish-PTT)
W91-04358

STUDY OF TRASH AND TRASh INTERCEPTION DEVICES.
University of Technology Sydney, Broadway (Australia). School of Civil Engineering.
M. G. Carleton, and J. S. Nielsen.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 287-290, 1990.1 fig, 1 tab, 6 ref.

Descriptors: *Sewer systems, *Storm water management, *Trash racks, *Urban runoff, Australia, Cleaning, Flow rates, Hydraulic design, Water pollution control, Water pollution effects.

The composition of trash found in urban stormwater runoff was analyzed following its collection by a trash rack and two floating booms in Sydney, Australia. Basically, garden refuse, plastic, and paper products were the main components of trash collected. The effectiveness of trash interception devices was examined using results of field trials. For various flow velocities, widths of channel or river, storm-related loads and cleansing frequency the choice of trash racks or booms can be made. Testing of a range of trash rack designs was performed in the laboratory with the principal aim of preventing rack blockages. While both spacing between bars and the angle of inclination of the rack were related to self-cleansing, ultimate blockage could not be prevented for the configuration tested. Either the racks should be designed to allow for overtopping when blocked or booms be used, despite their lesser efficiency. (Author's abstract)
W91-04359

KEEPING YOUR NEIGHBOR HAPPY.
New Jersey-American Water Co., Shrewsbury.
For primary bibliographic entry see Field 5F.
W91-04374

EFFECT OF ZINC ON OSMOREGULATION OF GAMMARUS DUEBENI (CRUSTACEA: AMPHIPODS) FROM THE ESTUARY AND THE SEWAGE TREATMENT WORKS AT LOOE, CORNWALL.
Polytechnic South West, Plymouth (England). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-04376

OZONATION OF TRACE ORGANIC COMPOUNDS: MODEL PREDICTIONS VERSUS EXPERIMENTAL DATA.
Middle East Technical Univ., Ankara (Turkey). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W91-04377

TREATMENT OF POULTRY PROCESSING WASTEWATER USING SEQUENCING BATCH REACTORS.
British Columbia Univ., Vancouver. Dept. of Bio-Resource Engineering.
K. V. Lo, and P. H. Liao.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 299-302, July 1990. 4 fig, 2 tab, 11 ref.

Descriptors: *Food-processing wastes, *Meat processing industry, *Poultry, *Wastewater reactors, *Wastewater treatment, Biological oxygen demand, Chemical oxygen demand, Denitrification, Nitrification, Retention time, Sludge volume index.

Sequencing batch reactor (SBR) systems are receiving increasing use for the treatment of municipal, industrial, and agricultural wastewaters. However, reports on the application of the SBR process to food processing wastewaters are scarce. Three five-liter bench-scale SBRs were used to treat poultry processing plant wastewater. The reactors were operated at three different temperatures (10, 22, and 35 C) and a cycle of four hours. Two liters of wastewater were treated each four-hour cycle. The mean hydraulic retention time was 10 hours for each reactor. High levels of reduction in biochemical oxygen demand and chemical oxygen demand were achieved. The reduction for biochemical oxygen demand was over 89%. There was no noticeable difference in the mean treatment efficiency of the SBRs operating at 22 and 35 C. However, the treatment efficiency of the low-temperature reactor (10 C) was lower. Denitrification was found to occur at the beginning of the react phase for the high-temperature (22 and 35 C) reactors, while no obvious denitrification or nitrification processes took place in the low-temperature reactor. The settling characteristics of the sludge were good with the sludge volume index ranging between 70 and 108. (Author's abstract)
W91-04550

FATE OF MUTAGENIC ACTIVITY DURING CONVENTIONAL TREATMENT OF MUNICIPAL WASTEWATER SLUDGE.
East Tennessee State Univ., Johnson City. Dept. of Health Sciences.
R. D. Blevins, and L. Brennan.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 657-664, September/October, 1990. 7 tab, 20 ref.

Descriptors: *Activated sludge process, *Municipal wastewater, *Mutagenicity, *Wastewater treatment, Ames test, Bioassay, Chlorination, Metabolic activity.

The mutagenic activity of wastewater was followed during conventional activated sludge treatment at a municipal plant. Raw wastewater was initially screened for mutagenic potential, using Ames Salmonella/mammalian microsomal test and employer tester strains. The combined raw wastewater produced dose-related mutagenic responses in the presence of S9 metabolic activation. Raw wastewater from domestic sources alone was not mutagenic. Mutagenic activity was observed throughout the treatment process. Activated sludge prior to chlorination contained the highest specific mutagenic activity. Chlorination decreased the specific mutagenic activity at pH 11. Mutagenic activity in municipal wastewater containing industrial discharges is not removed by conventional treatment processes and can be enhanced by activated sludge treatment. The Ames test cannot detect all the potential mutagens present in a sludge sample, particularly inorganic mutagens such as heavy metals. Therefore, other bioassays should be used in addition to the Ames test to determine the mutagenic activity of a sample. Furthermore, the Ames test does not provide information an plant bioaccumulation of these chemicals or the sample's threat to human health. (Author's abstract)
W91-04569

EXPOSURE ASSESSMENT OF SEWAGE TREATMENT PLANT EFFLUENT BY A SELECTED CHEMICAL MARKER METHOD.
Clement Associates, Inc., Fairfax, VA.
S. E. Holm, and J. G. Windsor.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 674-679, September/October, 1990. 9 fig, 15 ref.

Descriptors: *Chemical tracers, *Effluents, *Path of pollutants, *Tracers, *Wastewater outfall, *Wastewater pollution, Contaminants, Coprostanol, Effluent plumes, Hydrocarbons, Organic chemicals.

Organic chemicals unique to sewage effluent can be useful as markers of an effluent plume. Samples were collected at a domestic wastewater outfall near Cocoa, Florida, and chemically characterized. Receiving waters were analyzed to determine the chemical components in the effluent most suitable for the assessment. The saturated hydrocarbon fraction and sterol fraction appeared to be of greatest utility for such purposes, and the concentrations of these fractions were determined for water, particulate matter, and sediment. In all cases, concentrations were higher at the outfall than at a site 800 m from the outfall, though to what degree depended on the suite of compounds used in each phase and fraction. It was found that the presence of coprostanol was a good marker of areas exposed to sewage treatment plant effluent. Coprostanol may also indicate transport of other sewage outfall constituents such as pathogenic organisms, heavy metals, and harmful organics due to their similar adsorption kinetics. Concentrations of coprostanol were significantly higher at the sewage outfall site than at the 800 m site, thus providing an excellent marker to delineate an area adversely influenced by sewage contamination. However, coprostanol is also derived from agricultural waste and quite possibly from aquatic mammals such as manatees and porpoises. Thus, detecting coprostanol may reflect contamination from sources other than sewage treatment plants. (White-Reimer-PTT)
W91-04570

PRELIMINARY STUDIES ON THE DEVELOPMENT OF A MICROBIOLOGICAL TREATMENT FOR POLYCHLORINATED BIPHENYLS.
BioTreatment Ltd., Cardiff (Wales).
For primary bibliographic entry see Field 5G.
W91-04580

INTERCEPTOR DESIGN AND CONSTRUCTION CONSIDERATIONS AS PART OF THE BOSTON HARBOR CLEANUP.
S E A Consultants, Inc., Cambridge, MA.
J. J. Struzziery.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 8-9, November 1990.

Descriptors: *Boston Harbor, *Cleanup operations, *Massachusetts, *Pipelines, *Sewer systems, *Water pollution prevention, Construction, Costs, Design criteria, Environmental protection, Regulatory agencies, Wastewater pollution.

The Wellesley Extension Sewer Replacement (WESR) project, designed as part of the Boston Harbor cleanup operation, involves the design and construction of 7.5 miles of 60-in and 54-in diameter interceptor wastewater pipe; rehabilitation of an existing interceptor, which was installed in the early 1960s and has deteriorated due to hydrogen sulfide; and the abandonment of the Wellesley Extension Sewer (WES), which was installed between 1916 and 1921. The $66-million project is intended to provide adequate flow capacity for the next 40 years, reduce overflows and improve the harbor's water quality. The project has involved various federal, state, local, and private agencies

because of numerous environmental protection and permitting considerations. As part of the design, 7.5 miles of the existing reinforced concrete sewer pipe was inspected by internal television to determine the sewer's condition. Due to extensive deterioration rehabilitation was recommended that included inversion pipe lining and sliplining for the pipeline. Construction challenges include 3 crossings of the Charles River; construction under the bridge decks of a 6-lane, divided interstate highway where it crosses the river; 3 tunnels up to 3000 ft long; a crossing under a 24-in natural gas pipeline in rock conditions; and extensive crossings of wetlands and floodplains. Environmental controls require the contractors to monitor background noise and turbidity levels along the sewer alignment. By preventing raw sewage overflows into the Charles River, the long-term beneficial impact of this project will be better water quality and quality of life. (White-Reimer-PTT)
W91-04594

DEWATERING PROBLEMS LEAD TO LIQUID SLUDGE DISPOSAL.
Broward County Office of Environmental Services, Pompano Beach, FL. Wastewater Management Div.
J. M. Chansler, and D. R. Rowe.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 11,13, November 1990.

Descriptors: *Kentucky, *Sludge disposal, *Sludge drying, *Sludge utilization, Aerobic digestion, Crop yield, Cropland, Land disposal, Wastewater renovation, Wastewater treatment.

The upgraded Bowling Green (Kentucky) Wastewater Treatment Plant began operation in late 1976. Even after the usual, anticipated startup problems, it became clear that solids-handling facilities were inadequate. The three 1900-cu m digesters provided ample digestive facilities, but dewatering and disposal could not keep up. The 12 sand-drying beds with a total surface area of 2230 sq m, could not dewater at a sufficient rate. Therefore, vacuum filters from the original plant were pressed into service. However, although the plant effluent was well within limits for 20 hr/d, solids washout occurred for about 4 hours every day. At this point non-dewatered sludge land-spreading was considered. No formal sludge landspreading program existed in Kentucky at that time, but with the help of area farmers and state regulators, private-contractor bids were opened in October 1981 for non-dewatered sludge transport and disposal on state-approved sites. The process consists of wasting sludge separately from the primary and secondary treatment processes to aerobic digesters. This operation is followed by landspreading without dewatering. Landspreading has been limited mainly to corn and soy beans, with yield increases usually about 25%. Haul distance affects costs. The current contract is for a cost of 2.35 cents/gal. This type of wastewater reuse depends on the quality of the product as well as economics, and product quality is directly dependent on training, education, and experience. (White-Reimer-PTT)
W91-04595

LOS ANGELES CITY SLUDGE MANAGEMENT PROGRAM.
Los Angeles City Hyperion Treatment Plant, Playa Del Rey, CA.
For primary bibliographic entry see Field 5E.
W91-04596

AIR TOXICS PROJECT STUDIES HEALTH RISKS FROM WASTEWATER TREATMENT PLANT EMISSIONS.
Pirnie (Malcolm), Inc., White Plains, NY.
J. W. Wilson, and R. J. Califano.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 17-18, November 1990.

Descriptors: *Air pollution, *California, *Heavy metals, *Public health, *Volatile organic compounds, *Wastewater facilities, Arsenic, Beryllium, Cadmium, Chromium, Nickel, Scrubbers, Toxicity.

In March 1989, as a condition for permitting expansion at one of its plants, the South Coast Air Quality Management District (AQMD) mandated that the County Sanitation Districts of Orange County (CSDOC) conduct a comprehensive program to determine the impact of toxic air contaminants that might be released from expanded plant process units, to evaluate the possible increased health risks, and to implement the best available control technology for toxics (T-BACT), if appropriate. Plant emissions were tested for 18 target compounds of concern identified by AQMD--13 volatile organic compounds (VOCs) and 5 metals (arsenic, beryllium, cadmium, hexavalent chromium, and nickel). Using predicted ground-level contamination concentrations determined from the air quality dispersion modeling analysis, the assessment estimated hypothetical human exposure from inhalation, and then computed the individual cancer risks associated with that exposure, summing the risks for each contaminant to compute a cumulative lifetime individual cancer risk. The analysis concluded that the existing wet scrubbers used for odor control represented the T-BACT for this site. (White-Reimer-PTT)
W91-04597

DURHAM BENEFITS FROM COLLECTION SYSTEM INSTRUMENTATION.
M. Adcock.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 22,24, November 1990.

Descriptors: *North Carolina, *Sewer systems, *Telemetry, *Wastewater facilities, Combined sewer overflows, Maintenance, Monitoring, Overflow, Pumping stations, Sewer infiltration.

Durham, North Carolina has five wastewater treatment plants with a combined design capacity of 30 mgd. Older segments of the 750 miles of mainline sewers and 50 wastewater pumping stations suffer from joint deterioration, illegal connections, and a myriad of extraneous flow sources. These inflow and infiltration (I/I) problems reduce capacities in the sewer lines, lift stations, and treatment plants, because flows frequently double during moderate to heavy rains. The city adopted a goal of zero overflow by eliminating the worst I/I problems, systematically locating constrictions in the piping network, maximizing the efficiency of pump station and wet-well storage to maximize sewer system capacity, and installing a telemetered alarm system to alert personnel when high-level conditions or operational problems occur at pump stations or in critical sewer lines. About 25% of the pumping stations are now equipped with a 'smart' remote monitoring system. One of the innovative features of the monitoring system is its ability to monitor numerous operational parameters such as flow quantification, hourly and daily flow rates, and gpm for each pump on a daily basis. Daily maximum and minimum flow rates are also determined. The warning alarm system has become critical in reducing overflows and improving operation and maintenance activities at the stations. Early response has reduced certain equipment repair costs in many instances. (White-Reimer-PTT)
W91-04598

ANNE ARUNDEL COUNTY ACHIEVES WATER-QUALITY EXCELLENCE.
Anne Arundel County Dept. of Utilities, Glen Burnie, MD.
For primary bibliographic entry see Field 5G.
W91-04600

DESIGNING TO IMPROVE GRIT REMOVAL.
Brown and Caldwell, Pasadena, CA.
M. M. Anderson, H. G. Tran, and A. Bensen.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 54-57, November 1990. 4 fig.

Descriptors: *California, *Grit chambers, *Wastewater facilities, Design criteria, San Diego.

A 1987 construction project to expand grit removal facilities at San Diego's Point Loma Wastewater Treatment Plant improved grit removal by four times that of the original design's ability. The previous system (consisting of four aerated grit removal tanks, a below-grade grit pump room, and the headworks building) had allowed a significant amount of grit to escape the grit removal facilities, creating problems for the downstream sludge-handling facilities. The city frequently had to replace sludge pump stators and clean the digesters. The key to the success of the new system was a unique approach to designing the aerated grit removal system. The new facilities included two aerated grit removal tanks, a new motor control center building above the pump room, modifications to one agitation-air system, and additional grit separation facilities. The features that promote effective grit removal include the tank inlet design to direct flow of wastewater and the location of air diffusers on the opposite side, the effluent weir location, transverse baffles between grit hoppers, and longitudinal baffles between transverse baffles. Other features that ensure effective grit removal include a sloping wall above the grit hoppers, a broad-band diffuser for air introduction, tapered air feed at a relatively low rate, essential coordination of pumps with grit separators and dewaterers, returning overflows to the grit tanks, and the grit hopper design. The new system, which has been operating since May 1988, has already proven that it is clean, low maintenance, highly efficient, and reliable. (White-Reimer-PTT)
W91-04601

PAST PRACTICES AND NEW APPROACHES IN SCUM MANAGEMENT.
For primary bibliographic entry see Field 5G.
W91-04602

SPREADSHEETS FOR ESTIMATING SLUDGE PRODUCTION.
Greeley and Hansen, Philadelphia, PA.
For primary bibliographic entry see Field 7C.
W91-04603

PUMPING STATION REHABILITATION WITH SUBMERSIBLE PUMPS SAVES O&M COSTS.
BCM Engineers, Inc., Plymouth Meeting, PA.
T. E. Kunetz.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 6, p 16-18, November/December 1990. 2 fig.

Descriptors: *Pumping plants, *Pumps, *Sewer systems, *Wastewater collection, *Wastewater facilities, Construction, Design criteria, Maintenance, Maintenance costs, Operating costs, Pennsylvania, Safety.

The City of Sunbury in Northumberland County, PA, has three newly rehabilitated raw sewage pumping stations servicing the city's wastewater collection system. The three original pumping stations were constructed in 1948. They were satisfactory; however after 40 years of use, the pumps were beyond their usable service life and required constant attention and maintenance. Therefore, engineers were hired to inspect the stations and upgrade them to meet current safety standards. It was recommended that the pumping stations be modified to use submersible pumps that can easily be hoisted to the operating floor for maintenance or replacement, thereby reducing operation and maintenance costs and increasing safety considerations. The design for modifying the three pumping stations required precise coordination of the mechanical, structural, and electrical facilities within the close confines of the existing structures. The design modifications maintain the original capacity of each pumping station but alter the function of the original layout. Construction work to rehabilitate the three stations took approximately nine months. Since completion of the stations rehabilitation in late 1989, the pumps have run efficiently and maintenance has all been routine. (White-Reimer-PTT)
W91-04607

LATERAL INSTALLATION AND MAINTENANCE CONSIDERATIONS.
Gannett, Fleming, Corddry and Carpenter, Inc.,

Harrisburg, PA.
R. E. Shaffer.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 6, p 23-27, November/December 1990. 6 fig.

Descriptors: *Municipal wastewater, *Sewers, *Wastewater collection, Infiltration, Installation, Maintenance.

In a typical wastewater collection system, the length of service connection or lateral piping can equal or exceed the length of main line piping. Although it is normal for a municipality to establish criteria that determine that most, or even all, of a lateral is a property owner's responsibility, ineffective installation or maintenance by the property owner may ultimately create problems for the municipality. Therefore, lateral installation and maintenance considerations for pre-installation and post-installation are reviewed. Pre-installation considerations that should be addressed in municipal regulations include: permit application and installer registration;, material specifications and installation details; inspection and testing provisions; and ownership delineation and responsibilities. The most significant post-installation consideration for municipalities is the problem of infiltration. It generally causes no inconvenience to the property owner, but can add to municipal operating costs and overload municipal facilities. Cost effective internal lateral maintenance includes high-pressure water cleaning, internal television inspection, and internal repair. (White-Reimer-PTT)
W91-04608

WASTEWATER TREATMENT: DYE AND PIGMENT INDUSTRY (JAN 77--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-866602. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 42p.

Descriptors: *Bibliographies, *Dye industry wastes, *Wastewater treatment, Absorption, Activated carbon, Activated sludge process, Biodegradation, Dyes, Electrochemistry, Filtration, Ozonation, Reverse osmosis, Waste treatment.

This bibliography contains citations concerning treatment of wastewater containing dyes and pigments. The biological effect of dyes and pigments in wastewater treatment systems, the biodegradation of dyewastes, absorption and adsorption processes to remove dyes from wastewater, some environmental effects from the disposal of dye-containing wastes, and methods of analysis for dyes in waste streams are among the topics discussed. Treatment schemes such as ozonation, reverse osmosis, activated charcoal, activated sludge, electrochemical treatments, thermal treatments, simple filtration, an absorption are included. (This new bibliography contains 87 citations fully indexed with a title list.) (Author's abstract)
W91-04653

HUMIC ACIDS: CHARACTERIZATION AND INTERACTIONS IN NATURAL AND WASTEWATER SYSTEMS (JAN 78--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 2H.
W91-04655

ACTIVATED SLUDGE PROCESS: WASTE TREATMENT (JAN 85--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-867477. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 55p.

Descriptors: *Activated sludge, *Activated sludge process, *Bibliographies, *Waste treatment, *Wastewater treatment, Biochemistry, Biodegradation, Dairy industry wastes, Industrial wastes, Metals, Microbial degradation, Nutrients, Oxygen, Sludge digestion, Water level.

This bibliography contains citations concerning the use of the activated sludge process in waste and wastewater treatment. Biochemistry of the activated sludge process, the effects of various pollutants on process activity, effects of environmental variables such as oxygen and water levels, nutrient requirements of microorganisms employed in activated sludge processes, and the application of the process to specific wastes such as pharmaceuticals, halocarbons, metallic wastes, dairy wastes, coke plant wastewaters, and petrochemical effluents are among the topics discussed. Operating experiences at large plants are included. (This new bibliography contains 154 citations fully indexed with a title list.) (Author's abstract)
W91-04656

BIODEGRADATION OF PESTICIDES (DEC 85--MAY 90).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W91-04657

BIOFILMS AND BIOFILM REACTORS (APR 79--MAR 90).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-868399. Price codes: N01 in paper copy, N01 in microfiche. May 1990. 53p.

Descriptors: *Bibliographies, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Wastewater reactors, *Wastewater treatment, Biological treatment, Biomass, Fermentation, Fluidized beds, Kinetics, Microbial degradation, Model studies.

This bibliography contains citations concerning the formation and characterization of biofilms. Biofilms occur in fermentation, wastewater treatment, packed-bed reactors, fluidized-bed reactors, medical prostheses, fouling, biomass reactors, waste supply systems, and other aquatic systems. Topics include microorganism makeup of biofilms, controlling biofilm formation, biological and chemical properties, model studies, kinetic studies, and biofilm identification and detection. (This updated bibliography contains 152 citations, 19 of which are new entries to the previous edition.) (Author's abstract)
W91-04658

BIODEGRADATION OF PESTICIDES AND HERBICIDES (MAR 78--MAR 90).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-871872. Price codes: N01 in paper copy, N01 in microfiche. June 90. 89p.

Descriptors: *Bibliographies, *Biodegradation, *Fate of pollutants, *Herbicides, *Pesticides, *Wastewater treatment, Carbamates, DDT, Furans, Lindane, Malathion, Organochlorine pesticides, Organophosphorus pesticides, Path of pollutants.

This bibliography contains citations concerning the degradation of pesticides and herbicides by biological processes in the natural environment and in the laboratory. DDT, carbamates, organophosphorus compounds, malathion, 2,4,5-T, furans, lindane, and organochlorine compounds are among the chemicals discussed. The fate of these products in natural ecosystems after their application, the effects of these products on microbial community interactions, chemical details of biodestruction or biotransformation of pesticides, and the search for specific pesticide metabolizing organisms are also presented. (This updated bibliography contains 245 citations, 52 of which are new entries to the previous edition.) (Author's abstract)
W91-04659

OLIFANTSFONTEIN NUTRIENT REMOVAL PLANT.
Meiring and Barnard CC, Box 28734, Sunnyside, 0132, Republic of South Africa.
J. A. van Huyssteen, J. L. Barnard, and J. Hendriksz.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 1-8, 1990. 8 fig, 1 tab, 11 ref.

Descriptors: *Activated sludge process, *Nutrient removal, *South Africa, *Trickling filters, *Wastewater facilities, Chemical oxygen demand, Kjeldahl procedure, Model studies, Phosphorus removal.

An existing trickling filter (TF) plant was upgraded by adding a new activated sludge (AS) plant in order to remove nutrients from the combined effluent of both plants. The present plant treats waste derived from the Tembisa residential area and from the Olifantsfontein Industrial Township. The plant consists of the previously constructed trickling filter plant in parallel with the new three-stage Bardenpho plant. The effluent from the TF plant is then passed to the activated sludge plant for advanced treatment, including nutrient removal. The effluent is then passed through a plug-flow maturation pond before chlorination and discharge to the stream to which a phosphate standard of 1 mg P/L applies. In spite of a low COD/TKN (chemical oxygen demand/total Kjeldahl nitrogen) ratio, good nitrogen and phosphate removals were obtained in the three-stage Bardenpho (AS) plant. This is at variance with the University of Capetown mathematical model which predicted that nutrient removal in this plant would not be possible due to predicted recycle of nitrates to the anaerobic basin. The results showed that the average effluent phosphate was below 1 mg P/L while the ammonia and nitrates could be controlled to values well below the limits of the South Africa General Standard. Possible reasons for the anomaly are the presence of anoxic zones in the aeration basin and the induced storage of COD by microorganisms. (Agostine-PTT)
W91-04660

INNOVATIVE TECHNOLOGY FOR UPGRADING NUTRIENT REMOVAL ACTIVATED SLUDGE PLANTS.
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmental Protection.
J. Wanner, M. Kos, and P. Grau.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 9-20, 1990.2 fig, 7 tab, 41 ref.

Descriptors: *Activated sludge process, *Nutrient removal, *Wastewater facilities, *Wastewater management, Aeration, Anaerobic conditions, Anoxic conditions, Czechoslovakia, Denitrification, Nitrification, Project planning.

Four modifications of the nutrient removal activated sludge process were tested in pilot-plant units with a wastewater from the town of Pilsen: (1) the AB process with the B stage consisting of denitrification-nitrification sequence, (2) the denitrification-nitrification activated sludge process with the re-aeration of the returned sludge, (3) the modified Phoredox process with a feed divided in both the anaerobic and the anoxic zone, and (4) the preceding system with the re-aeration of the returned sludge. The re-aeration of the returned sludge proved to be advantageous for achieving high nitrogen removal. For the design of a new wastewater treatment plant for the town of Pilsen, the activated sludge process, consisting of the anaerobic-anoxic-oxic sequence with the re-aeration of the returned sludge, was used. The newly designed technological line of the so-called R-AN-D-N Process (re-aeration 'R', anaerobic 'AN', denitrification 'D', nitrification 'N') is very flexible due to the wastewater inlet in both the anaerobic and the anoxic zone and to the possibility of introducing the internal recycle in either the anoxic or the anaerobic zone. (Agostine-PTT)
W91-04661

UPGRADING A MUNICIPAL ACTIVATED SLUDGE PLANT FOR HIGH-RATE BIOLOGICAL NUTRIENT REMOVAL.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
C. W. Randall, D. Waltrip, and M. V. Wable.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 21-33, 1990. 10 fig, 6 tab.

Descriptors: *Activated sludge process, *Anaerobic digestion, *Municipal wastes, *Nutrient removal, *Phosphorus removal, *Wastewater facilities, *Wastewater treatment, Nitrification, Nitrogen removal, Planning, Retention time, Seasonal variation.

A full-scale activated sludge plant was modified for high-rate biological nutrient removal operation at minimal cost. Three different processes were studied at biological solids retention times varying from 4 to 14 days and hydraulic retention times of 2 to 6 hours. Onset of biological phosphate removal was almost immediate without addition of special seed. Good phosphorus removal was obtained with all three processes except for periods of extremely high influent flows or high nitrate recycle to the anaerobic zone. However, because of high process phosphorus loadings resulting from high influent concentrations and sludge processing recycles, effluent total phosphorus concentrations were typically in excess of 2 mg/L. Nitrogen removal was excellent when nitrification could be maintained and nitrate recycle was sufficiently high. All processes yielded excellent nitrogen removals during warm weather, but complete nitrification could not be maintained during winter conditions. Implementation of a statewide phosphate detergent ban resulted in a 40 percent decrease in the influent wastewater concentrations. Following the ban, the UCT process was shown to be capable of consistently meeting the Virginia nutrient discharge standards of 10 mg/L total nitrogen and 2 mg/L total phosphorus during the growing season. (Author's abstract)
W91-04662

UPGRADING WASTEWATER TREATMENT PLANTS WITH ANAEROBIC SELECTORS.
Air Products and Chemicals, Inc., Allentown, PA.
K. D. Tracy, and S. N. Hong.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 35-43, 1990. 8 fig, 2 tab, 11 ref.

Descriptors: *Activated sludge process, *Anaerobic digestion, *Wastewater facilities, *Wastewater treatment, Biochemical oxygen demand, Effluents, Nitrogen removal, Phosphorus removal, Sludge, Suspended solids, Wastewater management, Water quality standards.

The anaerobic selector of the A/O trademark process offers many advantages over conventional activated sludge processes with respect to process performance and operational stability. This high-rate, single-sludge process has been successfully demonstrated in full-scale operations for biological phosphorus removal and total nitrogen control in addition to biochemical oxygen demand (BOD) and total suspended solids (TSS) removal. Upgrades of two full-scale installations are described and performance data from the two facilities are presented. The two installations discussed utilized selectors to upgrade existing treatment plants to meet more stringent discharge limitations and to increase flow capacity. Based on the success of these installations and results of long-term operation, the following conclusions can be made: anaerobic selectors result in a stable process which can meet stringent effluent limitations including phosphorus and total nitrogen without chemical addition. The key factors in providing consistent nutrient removal are control of biomass inventory and management of phosphorus-containing sidestreams. The anaerobic selector results in a high-rate process that can be utilized to increase the capacity of existing treatment plants. Ease of retrofit makes the technology applicable to virtually any existing plant. The process can be successfully applied in any geographical area with wastewater temperatures ranging from 5 C to 30 C. (Agostine-PTT)
W91-04663

CONVERSION OF EXISTING PRIMARY CLARIFIERS ACCORDING TO THE EASC PROCESS FOR BIOLOGICAL PHOSPHORUS REMOVAL.
Linde A.G., Hoellriegelskreuth (Germany, F.R.).
R. Schonberger.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 45-51, 1990. 4 fig, 3 tab, 5 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Clarifiers, *Phosphorus removal, *Primary wastewater treatment, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Anaerobic conditions, Anoxic conditions, Germany, Nitrification, Nutrient removal, Seasonal variation.

At the end of 1988 a 22,000 population equivalent municipal wastewater treatment plant in Northern Germany was converted to the extended anaerobic sludge contact (EASC) biological phosphorus removal process. In the EASC-process, a primary clarifier is converted to an anaerobic settling basin into which both sewage and recycle sludge are fed after brief mixing. The supernatant of the basin as well as the sludge withdrawn from the bottom are then discharged into the aeration basin. The main advantage of an anaerobic settling basin is that it is possible to obtain a higher sludge detention time as compared to a mixed basin of the same size. A further advantage is that nitrate entering the settling basin with sewage (rainfall periods) or with recycle sludge (nitrifying activated sludge) does not disturb anaerobiosis to the same extent as in the case of a mixed basin. Due to stratification in the settling basin, anaerobic conditions in the thickening zone can coexist with anoxic conditions in the supernatant. The conversion to EASC involved simple modifications of the flow scheme of the plant. This operation mode achieves very good phosphorus uptake in the aeration basin. Since start up in November 1988, the uptake-capacity increased continually, since April 1989 phosphorus is removed down to concentrations of less than 1 mg/L PO4-P in the aeration basin. Due to an inadequate design and size of the existing final clarifier, phosphorus bleedback occurs and reduces removal efficiency. This bleedback could be minimized by either intensifying denitrification or reducing sludge detention time in the final clarifier. (Agostine-PTT)
W91-04664

UPGRADING WASTEWATER TREATMENT PLANTS FOR BIOLOGICAL NUTRIENT REMOVAL.
Stanley Environmental Sciences, Inc., Surrey (British Columbia).
B. Rabinowitz, T. D. Vassos, R. N. Dawson, and W. K. Oldham.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 53-60, 1990. 1 tab, 5 ref.

Descriptors: *Biological wastewater treatment, *Nutrient removal, *Reviews, *Wastewater facilities, *Wastewater treatment, Activated sludge process, British Columbia, Canada, Case studies, Hydraulic design, Nitrification, Nitrogen removal, Phosphorus removal, Project planning.

A brief review of recent developments in biological nitrogen and phosphorus removal technology is presented. Guidelines are outlined of how current understanding of these two removal mechanisms can be applied in the upgrading of existing wastewater treatment plants for biological nutrient removal. A case history dealing with the upgrading of the conventional activated sludge process located at Penticton, British Columbia, to a biological nutrient removal facility with a design flow of 18,200 cu m/d (4.0 IMGD) is presented as a design example. Process components requiring major modification were the headworks, bioreactors and sludge handling facilities. It was found that for the upgrading of conventional sludge processes for biological nutrient removal, careful consideration must be given to basic biological nutrient removal process theory, practice and operational experience. When nitrification is required to achieve low effluent ammonia concentrations, the benefits of denitrification with respect to energy and alkalinity recovery must also be considered. The enhancement of the influent wastewater characteristics through primary sludge fermentation is required in low organic strength wastewaters. The overall design principle in the upgrading of plants for biological nutrient removal should be to use as many of the existing process components as possible. This requires a thorough evaluation of the structural and mechanical condition, and the hydraulic characteristics of each existing process component with respect to their applicability in the upgraded nutrient removal plant. (Agostine-PTT)
W91-04665

RENOVATION OF AN EXTENDED AERATION PLANT FOR SIMULTANEOUS BIOLOGICAL REMOVAL OF NITROGEN AND PHOSPHORUS USING OXIC-ANAEROBIC-OXIC PROCESS.
Public Works Research Inst., Tsukuba (Japan). Water Quality Control Div.
K. Moriyama, K. Sato, Y. Harada, K. Washiyama, and K. Okamoto.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 61-68, 1990. 16 fig,1 tab, 2 ref.

Descriptors: *Aeration, *Biological wastewater treatment, *Dissolved oxygen, *Maintenance, *Nitrogen removal, *Nutrient removal, *Phosphorus removal, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Anaerobic conditions, Biochemical oxygen demand, Denitrification, Nitrification, Oxidation process.

The effect of the oxidation reduction potential (ORP) control system on the simultaneous removal of nitrogen and phosphorus, utilizing the oxic-anaerobic-oxic process, was investigated. A full-scale wastewater treatment plant which was designed as an extended aeration process was modified for this study. The optimum ORP at the first basin for the simultaneous removal was 125 mV. In the first oxic basin the nitrification reaction and the denitrification reaction occurred simultaneously to maintain the optimum level of the ORP value. The averaged values of the effluent of this process were 1 mg/L of total nitrogen (TN), 0.5 mg/L of total phosphorus (TP) and 5 mg/L of BOD respectively. Statistical analysis showed that the ORP control was more effective in comparison with the control of dissolved oxygen (DO) concentration for the operating method of this process. Additionally, it was supposed that the simultaneous nitrification and denitrification using the ORP control system was a reliable nitrogen removal system for renovating the conventional activated sludge process because the hydraulic retention time of the first basin used in this study was equal to that of the conventional process. In this method: (1) the optimum ORP value for simultaneous removal of nitrogen and phosphorus exists, and (2) that a completely mixed-flow single-reactor can act as a simultaneous nitrification and denitrification reactor, when its ORP value is kept at this proper value, and (3) simultaneous removal of nitrogen and phosphorus can be achieved. (Agostine-PTT)
W91-04666

UPGRADING OF WASTEWATER TREATMENT PLANTS FOR THE REDUCTION OF NITROGEN AND PHOSPHORUS IN SCHLESWIG-HOLSTEIN, FRG.
Hanover Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft und Abfalltechnik.
C. F. Seyfried, and E. Dammann.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 69-76, 1990. 5 fig, 1 tab, 6 ref.

Descriptors: *Germany, *Nitrogen removal, *Nutrient removal, *Phosphorus removal, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Aeration, Biological wastewater treatment, Coagulation, Computer models, Filters, Filtration, Nitrification, Seasonal variation, Sludge.

In order to solve the problems occurring in the North Sea and the Baltic Sea, programs for the reduction of nutrients in wastewater treatment plants were initiated in the Schleswig-Holstein region. In 1988, all wastewater treatment plants with capacities greater than 17,000 population equivalents were upgraded for phosphate reduc-

tion, to give effluent concentrations of less than 2 mg P/L. By 1995, standard values of total nitrogen less than 10 mg/L and phosphorus less than 0.5 mg/L are expected. This requires extensive denitrification and filtration in addition to phosphorus reduction processes and nitrification. During the first stage of the phosphorus reduction program, biological phosphorus reduction was installed at one plant, and the other plants used precipitation as the phosphorus reduction method. Plans were developed to introduce nitrogen and phosphorus reduction in all plants during the next stage of the program. Biological processes will be of particular importance. Designs for the expansion of several wastewater treatment plants are presented. In particular, the problems which result from seasonal peaks, high phosphorus concentrations, and the combination of trickling filter and activated sludge processes are discussed. One of the methods used to improve treatment performance throughout the year is optimization of aeration. The relationships between sludge load, surplus sludge production, sludge age, and disposable phosphorus concentration during biological phosphorus reduction was investigated using a calculation program. (Agostine-PTT)
W91-04667

UPGRADING OF THE TREATMENT PLANTS IN STOCKHOLM TO MEET MORE STRINGENT REQUIREMENTS.
Stockholm Water and Wastewater Works (Sweden).
J. Hultgren, L. G. Reinius, and M. Tendaj.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 77-84, 1990. 1 fig, 6 tab.

Descriptors: *Biochemical oxygen demand, *Nitrogen removal, *Stockholm, *Sweden, *Wastewater facilities, *Water quality standards, Aeration, Anoxic conditions, Biological wastewater treatment, Effluents, Filtration, Mathematical studies, Nutrient removal, Phosphorus removal, Sedimentation, Wastewater treatment.

The purification requirements for the Stockholm sewage treatment plants will become more stringent in the future. The expected limit values for the effluent, expressed as annual mean values are BOD7 10 mg/L, Tot-P 0.3 mg/L, Tot-N 15 mg/L. If these contents are multiplied by the design flow values for the three plants, the maximum quantities which may be released are obtained. If the municipalities are permitted to distribute these quantities as desired between the three plants, future necessary extensions can be optimized. The following main principles apply to an extension of the three plants. (1) Loudden plant: If the requirements are lower than the other two plants, this small plant could continue in operation with no other extensions than the inclusion of anoxic zones. (2) Bromma plant: The biological stage was extended during the 1982-84 period. For this reason, no further extensions of the aeration tanks are required, before 1995 at the earliest. A nitrogen removal with outgoing contents of Tot-N of 15-17 mg/L is expected to be achieved by measures taken to reduce the load on the biological stage instead. To meet the requirements for phosphorus removal, the plant will be extended with a filter stage after the existing biological stage. (3) Hendriksdal plant: At this plant, which is the largest, the largest extensions are planned. To meet the requirements for nitrogen removal, the present volumes in the aeration tanks will be tripled and will be utilized as anoxic and aerated zones as required. Three new lines with aeration tanks and secondary sedimentation tanks will be constructed. The existing aeration tanks will also be deepened from 5 to 12 m. The requirements for low phosphorus contents in the effluent will be met by installing a filter stage, as in the Bromma plant. (Agostine-PTT)
W91-04668

PRE-PRECIPITATION FACILITATES NITROGEN REMOVAL WITHOUT TANK EXPANSION.
Kemira Kemi A.B., Haelsingborg (Sweden).
I. Karlsson, and G. Smith.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 85-92, 1990. 10 fig, 4 tab, 4 ref.

Descriptors: *Coagulation, *Nitrogen removal, *Phosphorus removal, *Wastewater facilities, Biological wastewater treatment, Chemical precipitation, Denitrification, Nutrient removal, Scandinavia, Sludge.

For phosphorus reduction in Scandinavia, the mechanical and biological treatment processes have mainly been supplemented by the addition of a third stage, a chemical post-precipitation stage. Chemical post-precipitation has not achieved great success outside the Scandinavian countries because of the high investment cost and the less strict demands. For energy-saving reasons post-precipitation and simultaneous precipitation have been replaced by pre-precipitationin many plants. Chemically coagulated sewage water gives an effluent low in both suspended matter and organics. Use of chemical precipitation as the first step in waste water treatment improves nitrification in the following biological stage. The precipitated sludge contains 75% of the organic matter in the sewage and can by hydrolysis be converted to readily degradable organic matter, which supples a valuable carbon source for the denitrification process. Experiences from full-scale applications as well as pilot-plant and laboratory studies of the pre-precipitation process indicate that this is a cost effective and viable method. (Agostine-PTT)
W91-04669

UPGRADING FOR BIOLOGICAL NITROGEN REMOVAL: SOME FULL-SCALE EXPERIENCES FROM SWEDEN.
Malmo Water and Sewer Works (Sweden).
B. Andersson, and B. Rosen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 93-104, 1990. 6 fig, 1 tab, 7 ref.

Descriptors: *Biological wastewater treatment, *Denitrification, *Nitrification, *Nitrogen removal, *Nutrient removal, *Sweden, *Upgrading, *Wastewater facilities, *Wastewater treatment, Coagulation, Cost analysis, Future planning, Sludge.

Nitrogen removal is now required by the Swedish parliament. The new requirements will be in effect before 1995 and in some cases before 1992. A comprehensive development program has been started to meet the new demands. To coordinate all activities, a National Nitrogen Project has been formed. The general goal is to meet the demand by process development, using existing volumes rather than to invest in civil works. A Swedish concept has been developed, which in most cases has served as a guideline for the development program. The basic principles are to decrease the load on the biological process by pre-precipitation, to utilize the remaining organic content in the wastewater in a pre-denitrification system, to increase the active biomass in the biological system and to use a two-sludge system with post-denitrification. Some experiences in Sweden are as follows: A pre-denitrification system has been in operation in Falkenberg since 1983 with good results; Comprehensive full-scale and pilot tests are in operation at two sewage plants in Malmo; and the Norrkoping plant uses pre-precipitation followed by combined pre-denitrification and post-denitrification. The results of full-scale operation for nitrification and denitrification are promising despite low temperature during the winter time. The process mode has been adapted to the existing plants without too costly investments. Experiences so far have shown that a satisfactory nitrogen removal might be possible to reach provided certain criteria are met. Nitrification is of course imperative but does not seem to be as dependent on temperature as was expected. It is a matter of sludge age. Decreasing the load by improved pre-treatment and increasing the active biomass in the system are the major ways to improve nitrification in an existing plant. The carbon source for denitrification seems to be a critical issue for the reliable operation of a nitrogen removal plant. More knowledge about handling a post-denitrification system is also needed. (Agostine-PTT)
W91-04670

UPGRADING A LARGE MUNICIPAL SEWAGE TREATMENT PLANT BY A COMBINATION OF BIOLOGICAL AND CHEMICAL PROCESSES.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
H. H. Hahn, E. Hoffmann, A. Kleinschmidt, and R. Klute.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 105-112, 1990. 8 fig, 6 ref.

Descriptors: *Biological wastewater treatment, *Chemical treatment, *Municipal wastes, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Denitrification, Filtration, Nitrification, Nitrogen removal, Phosphorus removal, Project planning, Trickling filters.

The standards controlling sewage treatment are continuously changing. Thus, upgrading existing plants is a frequently encountered problem. In the past this meant structural changes, mostly in terms of enlarging existing facilities or addition of new units. More recently the possibilities of improving plant performance through chemical addition (inducing precipitation and coagulation) with or without intensified biological treatment have been explored. Chemical addition has become necessary in many instances due to the tightening of standards for phosphorus concentrations in the plant effluent. Extensive pilot-plant studies under boundary conditions of diverse nature have furnished data to identify the most efficient method of upgrading the central treatment plant of the city of Schweinfurt. One-stage biological treatment with chemical addition does not suffice, in particular in terms of ammonium oxidation. Two-stage biological treatment without chemical treatment is not sufficient in terms of phosphorus control. Thus, two-stage biological treatment as high-load trickling filters followed by low-load activated sludge units together with post-dosing of chemicals plus flotation/filtration appears as the most expedient concept for plant upgrading. The data obtained in this pilot-plant work can also be used to develop a basis for plant design in terms of most appropriate loading rates. Presently, possibilities for complete nitrogen removal in terms of nitrification and denitrification are being investigated. The configuration of trickling filter as a 1st stage with an activated sludge unit as a 2nd stage does not prevent such extensions. (Agostine-PTT)
W91-04671

EXAMPLES FOR THE UPGRADING OF EXISTING ACTIVATED SLUDGE PLANTS FOR NUTRIENT REMOVAL.
iat-Ingenieurberatung fur Abwassertechnik, Taubenheimstrasse 69, D-7000 Stuttgart 50, Germany.
W. Maier.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 113-121, 1990. 7 fig, 1 tab.

Descriptors: *Activated sludge process, *Germany, *Nutrient removal, *Project planning, *Wastewater facilities, *Wastewater treatment, Biochemical oxygen demand, Effluents, Future planning, Nitrification, Nitrogen removal, Phosphorus removal, Sludge, Suspended solids, Wastewater management, Water quality standards.

In view of the new effluent standards in West Germany, including nitrification and phosphorus elimination, many of the existing sewage treatment plants will have to be rebuilt or expanded. Another demand which will have to be dealt with in the near future is denitrification. Under consideration of the large BOD5-loads which were taken into account when designing the plants, many of them nitrify during the summer and can easily be converted to operate with nitrification. Principles for planning the upgrading of such plants have been laid down in order to achieve the required effluent concentrations. The first step in planning the extension of existing plants is the evaluation of the daily log-book to determine the actual loadings. The analysis of operating data such as sludge volume index, suspended solids, the quantity of sludge etc. gives indications of operational or construction weak points of the existing plant, which have to be considered when planning the extension. By summing up the actual loadings and the reserve for increasing population or future indus-

tries, the design loadings and flows for the future can be determined. As a result of comparing the current capacity with the future-related design loads, the necessary remedial measures can be determined. The new concept for the plant should consider: (1) integration of existing basins; (2) observance of the required effluent standards for nitrogen compounds; (3) phosphorus elimination; and (4) investigation of the consequences for sludge handling. Two examples show how the outlined principles of preparing new concepts are applicable. In both cases it was possible to integrate the existing basins in the future concept and thus minimize the volume of the required new buildings. (Agostine-PTT)
W91-04672

STEPS IN PLANNING THE EXPANSION OF THE LARGE SEWAGE TREATMENT PLANT AT BUCHENHOFEN, OPERATED BY THE WUPPER WATERSHED MANAGEMENT ASSOCIATION.
Wupperverband, Wuppertal (Germany, F.R.).
J. Londong, and S. Zander.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 123-129, 1990.3 fig, 5 tab, 3 ref.

Descriptors: *Germany, *Management planning, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Administrative agencies, Coagulation, Denitrification, Filtration, Flocculation, Nitrification, Nutrient removal, Project planning, Water quality standards.

Sewage from 700,000 population equivalents, roughly half of which is discharged by industry, is treated at the Buchenhofen plant operated by the Wupper Watershed Management Association, using a conventional, activated-sludge process without specific nutrient elimination. A draft management plan has been prepared for the receiving stream of the plant, the Lower Wupper. The chief uses of these waters are fixed in binding agreements. The use entailing the strictest requirements is recreational fishing, which demands surface water quality class II. Very substantial demands, which must be regarded as at least equivalent to state-of-the-art technology, are imposed on the Buchenhofen facility. The Institut fur Siedlungswasserbau, Wassergutewirtschaft und Abfalltechnik at the University of Stuttgart was commissioned to formulate realistic purification objectives for the treatment plant and to prepare expansion concepts. At Buchenhofen, the single-stage activated sludge process with nitrification and preliminary denitrification has proved to be the most effective method for eliminating nitrogen while simultaneous precipitation followed by flocculation-filtration is the best process for eliminating phosphorus. The extreme demands in terms of ammonium and nitrite rule out expansion of a plant of this size. The proposed designs therefore require validation through commercial-scale testing. Only after a 6 to 12-month test series has been evaluated will a draft design be prepared for approval, enabling the plant to be expanded and to fulfil the management planning objective of achieving surface quality water class II in the Wupper. (Author's abstract)
W91-04673

REHABILITATION AND UPGRADING OF THE BENI SUEF CITY WASTEWATER TREATMENT PLANT.
Mansoura Univ. (Egypt). Faculty of Engineering.
A. Fadel.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 131-138, 1990. 4 fig, 4 tab, 4 ref.

Descriptors: *Egypt, *Maintenance, *Project planning, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Cost analysis, Effluents, Filters, Primary wastewater treatment, Secondary wastewater treatment, Sedimentation.

The Beni Suef Wastewater Treatment Plant was constructed in 1956. It has primary treatment followed by secondary treatment employing intermediate rate trickling filters. The city of Beni Suef required the rehabilitation and upgrading of the existing 200 L/s plant to extend its capacity to 440 L/s by the year 2000. Several alternatives were considered within the constraints of limited space available for expansion, limitation of funding, requirements for cost-effectiveness in operation, and limited availability of skilled manpower. The alternatives considered included: (a) changing the filter medium, its mode of operation, and increasing the number of units, (b) changing the trickling filter to high rate and combining it with the activated sludge process, (c) dividing the flow into two parts, the first part to be treated using the existing system and the second part to be treated by activated sludge process, and (d) increasing the numbers of the different process units. The selection was based on technical, operational and economic evaluations. The alternatives were compared on the basis of system costs, shock load handling, treatment plant operation and predicted effluent quality. It was concluded that alternative (a) would be the most reliable. The recommendation for the primary treatment includes raising the grit removal channels, side walls, and adding an extra primary sedimentation tank with larger diameter than the existing basins. The recommendation for the secondary treatment includes changing the trickling filter medium to plastic, the mode of operation to high rate, and to add plate settlers to the existing final sedimentation tanks. The recommendation for sludge treatment includes increasing the drying beds area. (Agostine-PTT)
W91-04674

TERTIARY WASTE WATER TREATMENT WITH FLOTATION FILTERS.
Ahlstrom Aquaflow Oy, Tampere (Finland).
H. J. Kiuru.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 139-144, 1990. 1 fig, 1 tab, 1 ref.

Descriptors: *Filtration, *Flotation, *Industrial wastes, *Tertiary wastewater treatment, *Wastewater facilities, *Wastewater treatment, Clarification, Finland, Municipal wastes, Organic wastes, Reliability, Sedimentation.

The need for an extremely efficient removal of suspended solids in wastewater treatment arose in the early 1980's in the town of Savonlinna, when the wastewater of a fiberboard mill was taken into the municipal sewerage system to be treated with municipal wastewater. Due to the high content of organic compounds in the wastewater from the mill, the BOD7 load of the treatment plant was on an average twice as high as the BOD7 load for which the facility was designed. A solution was to find a tertiary treatment that would make it possible to control the removal of solids in all circumstances and ensure good operational results. Good results from pilot tests and a thorough study of the properties of the three removal operations of solids, namely sedimentation, flotation, and filtration, led to the idea of applying tertiary treatment with flotation filters. In a flotation filter, flotation can be operated on an on/off basis. This means that flotation can be used only when needed in order to improve the removal of solids after secondary clarification. This need arises when settling in the secondary clarifiers does not succeed well enough because of hydraulic overload or of disturbances in biological activity. The use of flotation when needed, between secondary clarification (sedimentation) and filtration results in a very good load bearing capacity and in a high degree of removal of solids. Excellent operational results can be achieved with almost total reliability in all operational circumstances at a very reasonable cost. (Agostine-PTT)
W91-04675

ULTRAVIOLET DISINFECTION IN MUNICIPAL WASTEWATER TREATMENT PLANTS.
Roorkee Univ. (India). Dept. of Civil Engineering.
J. Maarschalkerweerd, R. Murphy, and G. Sakamoto.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 145-152, 1990. 8 tab, 3 ref.

Descriptors: *Disinfection, *Municipal wastewater, *Ultraviolet radiation, *Wastewater facilities, *Wastewater treatment, Chlorination, Cost analysis, Effluents, Fecal coliforms, Municipal wastes, Water quality standards.

Pilot and full-scale studies of ultraviolet (UV) disinfection of wastewater have demonstrated that the process could consistently meet an effluent fecal coliform standard of 200/100 mL or less depending on suspended solids and UV transmission. Since 1984 over three hundred systems have been installed at municipal wastewater treatment plants in North America. The majority of these are in treatment plants which had been using chlorination. The UV systems have been retrofitted into the existing chlorine contact tanks or existing channels. The capital costs of retrofitting compare favorably to the costs of upgrading chlorination systems, especially when dechlorination is required. As experience is gained in the operation of these UV systems, their performance has been monitored for their disinfection efficiency and cost of operation. Several installations are examined and their performance and costs analyzed. The evidence to date supports the premise that UV disinfection can meet demands for reliable effluent disinfection in a cost effective manner. The case studies demonstrate that UV systems can de designed which require minimal maintenance and very little on-site modification. UV disinfection can reduce the bacterial concentrations to safe levels without introducing toxicants to fish in the receiving streams. (Author's abstract)
W91-04676

UPGRADING WASTEWATER TREATMENT BY WATER HYACINTH IN DEVELOPING COUNTRIES.
Roorkee Univ. (India). Dept. of Civil Engineering.
P. Kumar, and R. J. Garde.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 153-160, 1990. 8 fig, 3 tab, 11 ref.

Descriptors: *Artificial wetland treatment, *Biological wastewater treatment, *Developing countries, *Wastewater facilities, *Wastewater treatment, *Water hyacinth, Biochemical oxygen demand, Chemical oxygen demand, Dissolved oxygen, Facultative ponds, Model studies, Nitrogen, Phosphorus, Project planning.

With increasing stress on existing wastewater treatment systems, it is necessary either to upgrade existing unit(s) or to install entirely new treatment plant(s). Obviously, upgrading is preferred over the alternative of having a new system. Keeping this in view, an attempt was made to explore the possibility of upgrading existing facultative ponds using water hyacinth. Bench-scale batch studies were designed to compare the performance of a hyacinth treatment system with facultative ponds. Investigations were carried out with synthetic wastewater having COD in the range of 32.5-1090 mg/L. The efficiency of COD removal in water hyacinth ponds was 15-20 percent more than the facultative ponds. Based on the results, an empirical model has been proposed for COD removal kinetics. In the second phase of the project a hyacinth pond was continuously operated. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), total nitrogen (TN), total phosphorus (TP), pH, and dissolved oxygen (DO) were regularly monitored. The DO of the effluent from the hyacinth treatment system was considerably reduced. The effluent should be aerated before it is discharged. The results indicate that existing facultative ponds can be stocked with water hyacinth to improve their performance and hyacinth treatment systems can be installed to support the conventional treatment. (Author's abstract)
W91-04677

POST-DENITRIFICATION WITH CONTROLLED FEEDING OF ACTIVATED SLUDGE AS H DONATOR.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Gewaesserreinigungstechnik.
I. Sekoulov, R. Addicks, and J. Oles.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 161-170, 1990. 11 fig, 1 tab, 4 ref.

Descriptors: *Activated sludge process, *Denitrification, *Hydrogen, *Nitrogen removal, *Wastewater facilities, *Wastewater treatment,

Chemical oxygen demand, Effluents, Filters, Nitrification, Upgrading.

Enlargement and/or upgrading of already-existing sewage treatment plants can result in design and operation problems. In an activated-sludge (AS) system for BOD removal (first stage) followed by a trickling filter for nitrification (second stage), it is hard to achieve denitrification of the effluent without an external hydrogen donor. Treatment plants which use only two-stage nitrification can be expanded to full nitrogen removal with a post-denitrification system which uses thickened first-stage activated sludge from the AS sedimentation as an electron donor. To avoid an undesirable release of ammonium or a decrease in effluent COD, the anaerobic residence time of the AS should not exceed 5 hours. Under anoxic conditions there is even further COD degradation due to sludge stabilization, with no decrease in effluent quality. The amount of sludge which must be added depends on the demand (nitrate load) and the denitrification potential of the AS. It seems possible to optimize this system even further (with a hydraulic residence time of about 3 hours) without decreasing effluent quality. The energy requirement of this treatment system is much lower than for comparable single-stage AS processes. Considering the problems of low-loaded single-stage AS processes with high sludge volume indices and large recycle flow rates, this multiple-stage treatment process consisting of activated sludge reactor, trickling filter, and post-denitrification seems to be a promising practical alternative. (Agostine-PTT)
W91-04678

DEVELOPMENT OF A TWO-STAGE TREATMENT PLANT FOR EXTENSIVE NITROGEN AND PHOSPHORUS ELIMINATION.
Ruhr Univ., Bochum (Germany,, F.R.). Lehrstuhl fuer Siedlungswasserwirtschaft und Umwelttechnik.
G. Bahre, W. Firk, and M. Gassen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 171-179, 1990. 9 fig, 2 tab, 2 ref.

Descriptors: *Nitrogen removal, *Nutrient removal, *Phosphorus removal, *Upgrading, *Wastewater facilities, *Wastewater treatment, Aeration, Biochemical oxygen demand, Biological wastewater treatment, Chemical oxygen demand, Germany, Model studies, Physicochemical treatment, Project planning.

The need to upgrade an existing wastewater treatment plant for very high effluent qualities led to a competition among several consultants, initiated by the plant operator, the Erft River Board. The design proposal that was chosen included a two-stage biological system incorporating enhanced biological phosphorus removal in the first stage, and extensive nitrification/denitrification with additional physicochemical P-removal in the second stage prior to a final flocculation filter. As design guidelines for this process configuration were not available, it was decided to create a physical model of the system which would allow for modification of the processes, if necessary, and which could provide better design parameters. An institute of sanitary engineering was enlisted to carry out an investigation to optimize the different processes. It became evident that the intended design for single-stream biological phosphorus removal could not be achieved under the marginal conditions given for the first biological stage. Hence, a by-stream method is being installed. Furthermore, the necessity for proper control of the oxygenation capacity in both the first and second stage became evident. The close cooperation between the involved parties during the investigation is believed to have produced an optimized design which integrates the special requirements of the receiving water body with an economic wastewater treatment technology. (Agostine-PTT)
W91-04679

AERATED BIOFILTERS FOR NITRIFICATION AND EFFLUENT POLISHING.
CRITER, Colombes (France).
C. Paffoni, M. Gousailles, F. Rogalla, and P. Gilles.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 181-189, 1990. 9 fig, 2 tab, 39 ref.

Descriptors: *Aeration, *Biofilters, *Effluents, *Filters, *Nitrification, *Tertiary wastewater treatment, *Upgrading, *Wastewater facilities, *Wastewater treatment, *Water quality standards, Activated sludge process, Biochemical oxygen demand, Biological wastewater treatment, France, Packed beds, Project planning, Suspended solids.

To comply with new effluent discharge standards different upgrading methods for a highly loaded activated sludge plant were explored. The Acheres Treatment plant (of the city of Paris) is currently being extended to purify a flow corresponding to 8 million population equivalents. New technology for plant upgrading was tested on an industrial scale. Biological aerated filters combine aerobic degradation of pollutants with physical retention of suspended solids (SS) in one reactor. A high concentration of active biomass can be retained in the packed bed, and nitrifying bacteria can be attached to the filter media. Removal efficiency thus becomes independent of clarification and sludge settling, and ammonia oxidation can be achieved without sludge age requirements. Four parallel units were installed on a research platform, handling a total flow of 3000 cu m/d. A demonstration test program was carried out over a period of five years to assess the feasibility and performances of the process in line with a conventional activated sludge plant. The limits of loading to achieve different residual ammonia concentrations were studied and the influence of temperature on biological and hydraulic parameters was verified. The feasibility of a compact tertiary treatment for effluent polishing and nitrification was confirmed. Biological filters in series with conventional treatment plants allow the upgrading of effluent quality and thus extend the capacity of existing facilities. From an effluent of a high-rate activated sludge plant with around 30 mg/L for BOD, SS and N-NH4, a polished effluent of below 5 mg/L of BOD, SS, and N-NH4 can be obtained with an apparent hydraulic retention time below 1 hour. (Agostine-PTT)
W91-04680

UPGRADING OF SMALL MUNICIPAL WASTEWATER TREATMENT PLANTS WITH HEAVY DAIRY LOADING BY INTRODUCTION OF AERATED SUBMERGED BIOLOGICAL FILTERS.
Norges Tekniske Hoegskole, Trondheim.
H. Odegaard, and B. Rusten.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 191-198, 1990. 9 fig, 4 tab, 4 ref.

Descriptors: *Biological wastewater treatment, *Dairy industry, *Filters, *Municipal wastes, *Wastewater facilities, Activated sludge process, Aeration, Combined treatment, Farm wastes, Norway, Pilot plants, Rotating biological contactors.

Most of the dairies in Norway discharge their wastewater to the municipal sewers. Insufficient knowledge about the organic load coming from the dairies has resulted in inadequate design and organic overloading in the municipal wastewater treatment plants of this category. Several of the original plants that based their biological process upon rotating biological contactors (RBC) as the bioprocess, have experienced mechanical breakdown of the RBC system. The submerged aerated biological filter (SABF) has been introduced as an alternative biofilm method that may be used when broken down RBC-plants (or activated sludge plants) are to be upgraded. Results from pilot-plant experiments on dairy waste when the SABF is used for pretreatment as well as results from plants in practice where the SABF is used for combined treatment of the dairy and municipal wastewater show how pretreatment in a balancing tank may be established, and results from the use of an alternative floating biofilm media are given. These results indicated that biological processes in such plants should be designed both for daily and hourly loading. Balancing tanks, normally used for equalization of the flow, may also be used as biological pretreatment tanks with very little extra cost. The submerged, aerated, biological filter (SABF), has many advantages over other treatment alternatives in plants with heavy dairy loading. If used for pretreatment, volumetric removal rates up to 15-20 kg COD/cu-m d may be achieved depending on the filter media used. The experiences from upgrading of RBC-based combined precipitation plants with heavy dairy loading by the introduction of SABF, have generally been good in Norway. (Agostine-PTT)
W91-04681

NITRIFICATION AND DENITRIFICATION IN COMBINED ACTIVATED SLUDGE SYSTEMS.
Departamento Municipal de Agua e Esgoto, Porto Alegre (Brazil).
D. Wartchow.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 199-206, 1990. 2 fig, 4 tab, 14 ref.

Descriptors: *Activated sludge process, *Combined treatment, *Denitrification, *Nitrification, *Wastewater facilities, *Wastewater treatment, Biomass, Clarifiers, Pilot plants, Sludge, Suspended solids.

To determine the difference in the nitrification and denitrification capacity of fixed and suspended biomass in combined systems, various investigations into batch reactors as well as continuous flow activated sludge plants in laboratory and pilot scale were conducted. By adding porous support material a certain amount of biomass is fixed on this material in a conventional aeration basin of an activated sludge (AS) plant. The dimensioning of AS plants for nitrification considers the sludge age of the activated sludge. By fixing the biomass on the support material in the aeration basin, the sludge age can be raised without increasing the mixed liquor suspended solids (MLSS) and therefore without increasing the loading of the secondary clarifier. Measurements of the oxygen consumption of the suspended sludge and the fixed sludge in situ, as well as the nitrogen balances showed that the nitrogen capacity of the fixed biomass is about 20-30% less than that of the suspended biomass, related to the organic dry matter (MLSS). Also the fixed sludge had a lower organic dry matter than the suspended sludge. This led to the conclusion that there is no linear dependency between increasing the biomass in the aeration basin by adding support material and the nitrification capacity of the whole sludge mass. The combination of fixed biomass on porous support material and suspended biomass has the advantage of increasing the total biomass in the system. It was also shown that simultaneous denitrification takes place in the support material in the aerated basin under certain circumstances. (Agostine-PTT)
W91-04682

IMPROVEMENT OF EXISTING WASTEWATER TREATMENT PLANTS' EFFICIENCIES WITHOUT ENLARGEMENT OF TANKAGE BY APPLICATION OF THE LINPOR-PROCESS: CASE STUDIES.
Linde A.G., Munich (Germany, F.R.).
M. Morper, and A. Wildmoser.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 207-215, 1990. 6 fig, 6 tab, 5 ref.

Descriptors: *Activated sludge process, *Nitrification, *Wastewater facilities, *Wastewater treatment, Aeration, Biomass, Case studies, Clarifiers, Effluents, Germany, Project planning, Water quality standards.

Activated sludge plants with fine-bubble aeration can be conveniently upgraded by the application of a LINPOR-process. The outstanding feature of the LINPOR is an increase of active biomass concentration, thus a reduction of F/M-ratios. The biomass increase is achieved by filling up 15-30% of an activated sludge tank with highly porous plastic foam particles, which serve as a carrier for active biomass. For this carrier material, very high quality standards are required concerning such parameters as porosity, homogeneity, particle dimension, wetting as well as mechanical, chemical and bio-

logical stability. This is crucial for maximum treatment yield, trouble free plant performance and a maximum service life of the carrier material. Three types of processes are in operation for upgrading existing plants: (1) the LINPOR-C process for carbonaceous removal; (2) the LINPOR-C/N process for carbonaceous removal including simultaneous nitrification and denitrification; and (3) the LINPOR-N process for second step nitrification. The three case studies described refer to the LINPOR-C and the LINPOR-N processes. The LINPOR-C process operates with two types of biomass, i.e. MLSS is partially fixed to t he carrier material and partially existing in free suspension. The LINPOR-N process is applied for the nitrification of wastewater deficient in organic pollution, e.g. secondary clarifier effluents. The nitrifying biomass is totally fixed inside the carrier particles. The LINPOR process is a convenient method for upgrading activated sludge plants without enlargement of tankage. Use of the process results in an increase in the total MLSS concentration and a decrease in the F/M ratio. (Agostine-PTT)
W91-04683

PERFORMANCE INCREASE OF PAPERMILL WASTE WATER TREATMENT PLANTS BY A HIGH-CAPACITY TRICKLING FILTER INSERTED AS FIRST BIOLOGICAL STAGE.
Papiertechnische Stiftung fuer Forschung und Ausbildung in Papiererzeugung und -Verarbeitung, Munich (Germany, F.R.). Wasser- und Abwasserforschungsstelle.
C. H. Mobius, I. Demel, and R. Huster.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 217-223, 1990. 4 fig, 2 tab, 19 ref.

Descriptors: *Biological wastewater treatment, *Filters, *Pulp and paper industry, *Pulp wastes, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Biochemical oxygen demand, Carbohydrates, Chemical oxygen demand, Clarification, Filtration, Future planning, Hydraulic loading, Sedimentation.

In many cases it will be advisable to enhance operational safety and increase degradation performance of existing activated sludge plants by inserting a high-capacity trickling filter with plastic media. Pilot plant tests of wastewaters of five paper mills producing different types of paper have been evaluated. Random samples were taken in the outflow of the trickling filter and filtered immediately irrespective of whether or not a subsequent sedimentation tank was provided. In the tests reported, the hydraulic loading was varied between 1.8 and 4.2 m/h. Recycling rates were between 10,000% and 60%. In other tests, trials were made with surface loads as low as 0.5 m/h. In order to obtain a BOD elimination of approximately 50%, the trickling filters should be designed and operated on the basis of the following: BOD volume loading 2-3 kg/cu m d, hydraulic cross-sectional surface loading 2.5 to 4 m/h, sprinkler intensity 6 mm as recommended by the manufacturer of the plastic media. No clarifier should be inserted between the trickling filter and the subsequent activated sludge stage. This results in a favorable sedimentation behavior of the activated sludge. A significant performance increase of the activated sludge plant can be achieved by way of carbohydrate elimination in the trickling filter. Maximum COD elimination is obtained in the treatment of papermill wastewaters if the aeration tank following the trickling filter is operated at 0.15 kg BOD per kg MLSS and day. (Agostine-PTT)
W91-04684

UPGRADING OF A COMBINED INDUSTRIAL AND MUNICIPAL WASTEWATER TREATMENT PLANT: THE FREDERICIA PLANT, DENMARK.
Krouger (I.) A/S, Soeborg (Denmark). Research and Development Div.
G. Petersen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 225-232, 1990. 4 fig, 5 tab, 3 ref.

Descriptors: *Denitrification, *Denmark, *Industrial wastes, *Municipal wastes, *Nitrification, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Biological wastewater treatment, Mathematical models, Pilot plants, Project planning.

The upgrading of an existing wastewater treatment plant to meet new standards for effluent quality in the Municipality of Fredericia, Denmark are presented. In 1987 pilot-scale tests were carried out to study the effects of various combinations of wastewater types on the treatment efficiency. The pilot-scale tests were run in a two-stage biology plant. The first stage was either a BIOSORPTION unit or a PRE-DENITRIFICATION unit. The second stage was a biological nitrogen and phosphorus removal unit (a BIO-DENIPHO unit). On the basis of the experimental results combined with the application of mathematical modeling of the activated sludge process in alternating tank systems, calibrated with the measured process parameters, two main projects for the upgrading of the existing plant were proposed. Project I is a two-stage biological treatment. This project includes a pre-denitrification/primary settling unit ahead of the BIO-DENIPHO system. Sludge treatment from the first biological stage is performed in the existing digesters. Project II is a one stage biological treatment. All of the biological treatment (nitrification and denitrification) is carried out in a one-sludge system operating according to the concept following the existing primary settlers. At the moment calculations on the total economics of the two main projects are being studied by the local administration in the Municipality of Fredericia before the final choice will be made. (Author's abstract) (Agostine-PTT)
W91-04685

DOSAGE CONTROL FOR A HIGHER EFFICIENCY OF THE SEPARATION PROCESS.
BTG Anlagentechnik G.m.b.H., Bochum (Germany, F.R.).
G. Schrank.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 233-243, 1990. 9 fig, 2 tab, 15 ref.

Descriptors: *Flocculation, *Polymers, *Sedimentation basins, *Sludge drying, *Wastewater facilities, *Wastewater treatment, Cost analysis, Filtration, Flotation, Germany, Project planning, Solids contact processes.

The two essential process steps in wastewater treatment are the biological decomposition and the separation of solids and liquid. Solids are separated from the liquid stream in several process steps. The variety of flocculents makes it very difficult to control the polymer dosage, and the predicted effectiveness of this process step cannot be achieved. To counter this difficulty, a control system that works in most applications has been developed. This system works almost independently of the separation process or the type of flocculent used. Three different field installations in different applications are given as examples: a sedimentation basin, a flotation cell and a filtration plant. These show that it is possible to build up sufficiently precise control systems for the solid-liquid separation by measuring the amount of solids contained and the turbidity. In the field of wastewater treatment this can bring about considerable process improvements which, in addition to a stabilization of the separation degree, may also enable considerable savings of chemicals. The experience made in sludge dewatering shows that the use of such a system is possible with good results. It should, however, not be ignored that the system also has its limits which are largely dependent on the separator. Depending on the function of operation in the past as well as on the size of the plant, the payback period will most certainly cover less than half a year. (Agostine-PTT)
W91-04686

UPGRADING EXISTING ACTIVATED SLUDGE TREATMENT PLANTS WITH FINE PORE AERATION SYSTEMS.
California Univ., Los Angeles. Dept. of Civil Engineering.
M. K. Stenstrom.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 245-251, 1990. 4 fig, 2 tab, 7 ref.

Descriptors: *Activated sludge process, *Aeration, *Diffusers, *Upgrading, *Wastewater facilities, *Wastewater treatment, Comparison studies, Cost analysis, Hydrogen chloride.

Over the past ten years aeration systems development in the United States has centered around fine pore diffuser upgrades to existing activated sludge plants. A variety of older aeration systems have been replaced with new diffuser systems which include full floor coverage systems, composed of ceramic or plastic discs, ceramic and plastic tubes, and membrane tubes or discs. Aeration system upgrades using these devices were evaluated using the off-gas analysis technique at six different full-scale treatment plants. Testing was performed during normal plant operation. Diffuser cleaning methods such as HCl gas cleaning, manual hosing and cleaning with HCl, and manual hosing, were also evaluated. It was found that the effects of process operation, such as step-feed, F/M, MLSS concentration, mean cell retention time and air flux had a major impact on transfer efficiency. In general the increased oxygen transfer rate could provide 40 to 50% reductions in air requirements, or a comparable energy saving. For all of these plants some type of diffuser cleaning program is required to maintain the energy savings. The energy savings suggests that it is possible to justify the capital investment required to retrofit the aeration system, under economic conditions typical of Southern California. (Agostine-PTT)
W91-04687

UPGRADING OXYGEN TRANSFER IN THE ACTIVATED SLUDGE PROCESS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Sanitary and Environmental Engineering.
M. Pelkonen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 253-260, 1990. 2 fig, 3 tab, 15 ref.

Descriptors: *Activated sludge process, *Aeration, *Oxygenation, *Upgrading, *Wastewater facilities, Cost analysis, Dissolved oxygen, Finland, Mathematical studies, Regression analysis, Seasonal variation.

The selection of an aeration system is of importance in order to optimize capital and operating costs, especially energy costs. Aeration efficiency is the variable which is used as the basis for comparison. The aeration efficiency values are based on pure water tests and are converted in to field conditions with the alpha factor. The alpha value depends on the impurities in the wastewater and the aeration system. Factors affecting oxygen transfer in a fine-pore diffused aeration system and variation of the alpha factor are discussed. Results from a five week continuous operation of a batch aeration column process show that the variation of the alpha value was considerable in the aeration basin, especially at the inlet end. The variation follows a diurnal rhythm and the weekly variation is much smaller. The off-gas method was used to examine factors affecting oxygen transfer in process conditions. Regression models were constructed to describe the transfer process both on a semi-technical scale and on a full scale. The cost important factors are the specific air flow rate, the respiration rate and the dissolved oxygen (DO) concentration. The enhancement in oxygen transfer efficiency through the respiration rate and the DO concentration is due to a biological mechanism. To optimize the transfer process it is necessary to maintain a high respiration rate and a sufficiently high DO concentration. (Agostine-PTT)
W91-04688

OPTIMIZING POLYMER CONSUMPTION IN SLUDGE DEWATERING APPLICATIONS.
ZENON Water Systems, Inc., Burlington (Ontario).
P. M. Crawford.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 261-267, 1990. 8 fig, 5 ref.

Descriptors: *Activated sludge process, *Control systems, *Polymers, *Sludge drying, *Wastewater

facilities, *Wastewater treatment, Automation, Canada, Rheology, Sludge.

Organic polymers have become the primary choice of conditioning agent for sludge dewatering operations. Until now, however, there has been no simple technique of automatically controlling the addition of polymer to the sludge to allow the optimal performance of the dewatering machine. The Sludge Conditioning Controller (SCC) to fulfill this need in the wastewater marketplace. The SCC is a unique, on-line, real-time sludge monitoring and polymer flow rate controller. The SCC determines the state of sludge conditioning directly by measuring the intrinsic rheological characteristics of both the conditioned and unconditioned sludge. It then changes the polymer flow signal to adjust the amount of polymer added to the sludge. The hardware for an SCC consists of four main components: (1) central control panel, (2) sample vessel and sensor head, (3) local control station, and (4) printer. The SCC hardware is entirely automatic in operation from taking batch samples of sludge to self-cleaning after sample analysis, to adjusting the polymer pump flow rate. The only requirement for the operator is to adjust the initial polymer dosage to get the desired sludge dewatering. Experience with full-scale systems has revealed that the benefits associated with the SCC far exceed the original objective of saving polymer. The advantages of the SCC include automation of the dewatering device operation, increased capacity, and more uniform performance of the dewatering machine. (Agostine-PTT)
W91-04689

BIOLOGICAL NITROGEN REMOVAL IN A COMPLETE MIXING TYPE AERATOR WITH ORP CONTROL.
Yamaguchi Univ. (Japan). Dept. of Civil Engineering.
H. Nakanishi, M. Fukagawa, M. Takeuchi, M. Ishikawa, and M. Ukita.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 269-270, 1990. 2 ref.

Descriptors: *Aerators, *Biological wastewater treatment, *Nitrogen removal, *Nutrient removal, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Denitrification, Dissolved oxygen, Effluents, Nitrification, Oxidation.

The nitrogen removal from wastewater has been shown to be successful in a complete mixing type aerator into which the optimum amount of oxygen was supplied automatically by the on-off control of aeration with ORP as an operational parameter. The usual process of biological nitrogen removal consists of two reactors in series, with one aerated to nitrify and the other unaerated to denitrify. The operation parameters were investigated on pH, ORP and DO by means of bench-scale experiments. At a pH range of 6.8 to 7.8, under either DO or ORP control, the reaction rates of nitrification and denitrification were balanced and the maximum nitrogen removal was obtained. The optimum DO level for DO control was within 0.0 to 0.3 mg/L in either night soil or sewage treatment. The optimum ORP level was 250-350 mV (vs NHE) in the night soil and 350-450 mV in the sewage. Nitrification or denitrification was limiting below or beyond each optimum ORP range, resulting in increase of ammonia or nitrate in the effluent. The advantages of the single aerator process with ORP control are: (1) the retention time is the same as that in the conventional activated sludge process; (2) this process is stable against the load variation because an optimum air supply is performed automatically. The disadvantage is that the electrical power for mixing the liquor is costly, thus limiting this process for small scale plants. (Agostine-PTT)
W91-04690

INVESTIGATIONS ON NITROGEN ELIMINATION IN SEWAGE TREATMENT PLANTS INCLUDING SEPARATE AERATION OF RETURN SLUDGE.
Kaiserslautern Univ. (Germany, F.R.). Fachgebiet Siedlungswasserwirtschaft.
M. Horster, and K. Jacobitz.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 271-272, 1990. 1 fig, 1 tab.

Descriptors: *Activated sludge process, *Aeration, *Nitrogen removal, *Wastewater facilities, *Wastewater treatment, Cost analysis, Denitrification, Effluents, Germany, Nitrification, Pilot plants.

A process to improve effluent quality of existing treatment plants has been examined. The process combines a conventional activated sludge plant with separate aeration of return sludge. Both pilot and large-scale plants used for the experiments consist of an aerated grit chamber, primary settling tank, six cascades for biological treatment, secondary settling tank and sludge treatment. One cascade can be used for the separate aeration of return sludge (SAS) before mixing the sludge with the influent. Thus, the sludge amount and the sludge age held in the system increase significantly. Comparisons were made to examine the effect of separate aeration of return sludge without a change in the total aerated volume. For conventional treatment the primary effluent and the return sludge were introduced into the basin normally operated for separate sludge aeration. The nitrification capacity of a plant with separate aerated sludge was also explored. In another experiment the possibility of a preliminary denitrification using the first aerated basin as an anoxic zone was investigated. The pilot-scale tests included the addition of digester overflow to the SAS respectively to the first aeration basin during conventional treatment. It was found that by the integration of separate aeration of return sludge in a compartmentalized system, nitrification can be increased significantly compared with conventional high-rate activated sludge plants. The inclusion of a denitrification zone is possible. The results indicate the practicability for the sanitation of sewage treatment plants sparing reactor volume. Little capital expenditure would be necessary for the modification of plug-flow reactors. (Agostine-PTT)
W91-04691

HOW TO INCREASE EFFICIENCY OF SEWAGE PLANTS AND OBEY THE LATEST REGULATIONS.
Sued-Chemie A.G., Munich (Germany, F.R.).
A. Huber.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 273-274, 1990. 2 fig.

Descriptors: *Flocculation, *Regulations, *Silicates, *Sludge drying, *Wastewater facilities, *Wastewater treatment, *Water quality standards, Aluminum, Coagulation, Filtration, Germany, Heavy metals, Iron, Nitrification, Sludge treatment.

Sudflock is a precipitation agent and flocculent consisting of Al(+3) and Fe(+3) ions. It also has a silicic acid which acts as a flocculation aid. Higher concentrations of calcium and magnesium also have specific precipitation effects. The synergism of the various components is very important. In special cases, the variable content of hydrochloric acid can help in the neutralization of alkaline wastewater resulting from the cleavage of emulsions. Sudflock has been used to increase efficiency at three sewage treatment plants. Compared to tests with FeCl3 and FeClSO4, sewage sludge conditioning in filter presses was very effective in the dehydration of sewage sludge. The required amount of Sudflock is much lower (about 50%) than for FeClSO4 of FeCl3. The required amount of lime is also reduced. Sudflock does not impair the agricultural use of sewage sludge. In some cases, the heavy metal content of the sewage sludge is almost 20% lower than before the use of Sudflock. In many cases, the use of Sudflock improves nitrification or makes it possible. The reduction of organic load leads to a sufficient amount of oxygen for nitrification. (Agostine-PTT)
W91-04692

RETROFITTING ACTIVATED SLUDGE PLANTS TO IMPROVE THE REMOVAL OF NITROGEN AND PHOSPHORUS BY BIOLOGICAL PROCESSES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
C. W. Randall, D. Sen, and T. J. Grizzard.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 275-276, 1990.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Phosphorus removal, *Upgrading, *Wastewater facilities, *Wastewater treatment, Anaerobic conditions, Denitrification, Hydraulic loading, Municipal wastes, Nitrification, Nitrogen removal, Nutrient removal, Sludge disposal, Sludge treatment.

Two relatively small municipal activated sludge wastewater treatment plants were modified to implement biological nutrient removal (BNR). One plant was a racetrack oxidation ditch without primary settling, equipped with three evenly-spaced brush aerators. It received an average influent flow of 8.3 megaliters per day (ML/d), which resulted in an average hydraulic retention time (HRT) of 16 hours when one ditch was in operation. The second plant was a small (2.8 ML/d), U-shaped, step aeration system with an HRT of 4.5 hours at average flow, primary settling of combined influent wastewater and WAS and land disposal of waste sludge. The oxidation ditch investigation had four objectives: (1) to modify operation of the ditch aeration system to maximize biological nitrogen (N) removal simultaneously with chemical P removal; (2) to operate the system without chemical removal to determine if simultaneous P and N removal could be obtained; (3) operate both ditches in parallel to maintain N removal under low temperature conditions; and (4) retrofit the ditch system with an upstream anaerobic basin to maximize biological P removal simultaneously with N removal. The efforts to improve N removal were very successful. The reduction of oxygen inputs resulted in simultaneous nitrification and denitrification in the ditch and reduced the effluent total nitrogen (TN) concentrations to less than 10 mg/L from an influent of about 35 mg/L. Biological phosphorus removal (BPR) was established in the oxidation ditch without the development of a separate anaerobic zone. Several physical constraints can limit biological removal of nitrogen and phosphorus in small activated sludge plants when they are retrofitted for BNR. The small step-aeration plant was substantially overloaded, both hydraulically and with respect to its aeration system. In spite of the system limitations, the plant achieved substantial N and P removal. (Agostine-PTT)
W91-04693

IMPROVED PHOSPHORUS ELIMINATION AND NITROGEN OXIDATION THROUGH PRE-PRECIPITATION.
Erftverband, Bergheim (Germany, F.R.).
W. Firk.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 277-278, 1990. 2 fig.

Descriptors: *Activated sludge process, *Coagulation, *Nitrogen removal, *Oxidation, *Phosphorus removal, *Upgrading, *Wastewater facilities, *Wastewater treatment, Aeration, Biochemical oxygen demand, Biological wastewater treatment, Cost analysis, Denitrification, Germany, Nitrification, Sludge.

The process technology of many conventional treatment plants lacks specific phosphorus elimination and adequate denitrification measures. Pre-precipitation represents a low-cost option for enhancing such plants. The phosphorus is reduced through the use of precipitation chemicals in the preliminary treatment stage and further eliminated in the subsequent biological stage. Improved retention of BOD5-producing sewage constituents by pre-precipitation allows substantial reduction of sludge loads in the activated sludge stage. Together with specific reduction of particulate BOD5-producing sewage constituents, this significantly prolongs the sludge age of the activated sludge. Given sufficient aeration capacity, a sewage treatment plant enhanced at low cost in this was is largely capable of performing the necessary nitrification and phosphorus elimination tasks. The Erft

River Board is currently conducting commercial-scale pre-precipitation tests in a treatment plant with approximately 50000 population equivalents. Results for polyaluminum chloride as a pre-precipitation agent in terms of the parameters BOD5, COD, phosphorus and ammonium are reported. In addition to a distinct reduction in phosphorus, nitrification was achieved in the previously non-ammonium-oxidizing plant. A BOD5-reduction and a P-reduction of 60% were achieved with the pre-precipitation. (Agostine-PTT)
W91-04694

COMPARATIVE STUDY OF BIOLOGICAL PHOSPHORUS REMOVAL BY ACTIVATED SLUDGE IN A PILOT PLANT AND IN LABORATORY BATCH EXPERIMENTS.
Freiburg Univ. (Germany, F.R.). Inst. fuer Biologie 2.
M. Streichan, D. Junghans, and G. Schon.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 279-280, 1990. 2 fig, 2 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Nitrogen removal, *Nutrient removal, *Phosphorus removal, *Pilot plants, *Wastewater facilities, *Wastewater treatment, Anaerobic conditions, Bacteria, Comparison studies, Germany, Mathematical studies.

Phosphate uptake in batch experiments by activated sludge from a pilot plant was investigated for a period of several months. The plant was modified for enhanced biological phosphorus removal by the extended anaerobic sludge contact (EASC) process. Immediately after conversion of the plant to the EASC-process, phosphorus removal in the plant and phosphate uptake in batch experiments increased linearly at the same rate. Maximum efficiency of excess phosphate uptake was reached in the plant as well as in the laboratory batch experiments after about 14 days of operation. An extended study over several months showed a good correlation between phosphate uptake in laboratory batch cultures by activated sludge obtained from the plant and phosphorus removal in the plant itself. Examination of activated sludge flocs by electron microscopy revealed that the number of polyphosphate-accumulating bacteria increased with increasing phosphorus elimination. The direct correlation between the phosphate uptake of activated sludge in laboratory batch experiments and the phosphorus removal in the pilot plant shows that the potential activity of activated sludge to remove phosphorus can be easily determined under laboratory conditions. In many cases, the reason for breakdowns of phosphorus elimination in treatment plants could thus be examined in a relatively simple manner. (Agostine-PTT)
W91-04695

EFFECT OF EASILY DEGRADABLE CARBON SOURCES ON NITROGEN REMOVAL EFFICIENCY.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Water Resources Engineering.
E. Plaza, B. Hultman, and J. Trela.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 281-282, 1990. 2 fig, 3 ref.

Descriptors: *Degradation, *Nitrogen removal, *Nutrient sources, *Wastewater facilities, *Wastewater treatment, Acetic acid, Anoxic conditions, Chemical oxygen demand, Coagulation, Denitrification, Pilot plants, Sludge thickening, Sweden.

To investigate the possibilities of increasing nitrogen removal efficiency at the Himmerfjarden sewage treatment plant, pilot-plant studies were performed in which pre-precipitated wastewater was supplemented with easily degradable carbon sources. The pilot plant was designed for pre-denitrification with an anoxic fraction of 0.25. The carbon sources studied were acetic acid and (ethylene) glycol. Glycol was delivered as a waste product from Arlanda airport. In addition, the supernatant from primary thickeners was studied as a possible carbon source. The experiments were monitored by both grab samples and continuous measurements of parameters. The results indicate that the value of the sludge age/1.127 must exceed 6-6.5 days in order to secure an effluent ammonia-nitrogen concentration below 0.5 g N/cu m. The temperature in the experiments varied between 6 and 23 C. Supernatant from primary sludge thickening tanks seems to inhibit the nitrification process. The nitrogen removal efficiency diminished with a lowering of the COD/N ratio. Based on a theoretical model, the removal efficiency of nitrogen is approximately proportional to the COD/N ratio for a certain carbon source and a certain fraction of the anoxic zone as long as the nitrate concentration in the anoxic zone does not limit the denitrification rate. (Agostine-PTT)
W91-04696

OPERATIONAL EXPERIENCE WITH PHOSPHORUS AND NITROGEN REMOVAL AT THE HIMMERFJARDEN PLANT, SWEDEN.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Water Resources Engineering.
E. Plaza, J. Bosander, A. Dahlberg, and B. G. Hellstrom.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 283-284, 1990. 1 fig, 1 tab, 1 ref.

Descriptors: *Nitrogen removal, *Phosphorus removal, *Regulations, *Sweden, *Wastewater facilities, *Wastewater treatment, Aeration, Biological wastewater treatment, Chemical treatment, Coagulation, Denitrification, Ferrous sulfate, Nitrification, Nutrient sources, Water quality standards.

Beginning in 1995 the Ministry of Environmental Protection is considering the establishment of 50% reduction of nitrogen as a requirement for Swedish wastewater treatment plants. The Himmerfjarden Sewage Treatment Plant was built in 1974 with mechanical, biological and chemical treatment. To reduce the phosphorus content and the organic load at the activated sludge units, computer-controlled pre-precipitation with ferrous sulfate has been used for nine years at the Himmerfjarden Plant. Before the sewage enters the aeration tanks, 50% of the phosphorus and 50% of the BOD7 content are removed. This improves the nitrification efficiency in the aeration tanks. Only the difficult degradable carbon compounds are reduced by the pre-precipitation, while the easily degradable carbon compounds are available as a carbon source for the denitrification process. Experiments to confirm this are presently being conducted. Biological nitrogen removal was applied at the Himmerfjarden Plant starting in 1988. Nitrogen removal is done by introducing anoxic zones in front of the activated sludge tanks. The internal energy source from influent wastewater is used for denitrification. Excluding the periods with high flow during snow melting, a nitrification efficiency of over 90% is obtained. The annual average of the nitrogen removal efficiency is about 40%; large oscillations occur from day to day. The denitrification process is limited by lack of organic carbon in the wastewater. The maximum degree of denitrification is controlled by the carbon/nitrogen (C/N) ratio. To obtain a higher nitrogen efficiency in the existing system, the external carbon source should be dosed during the low-loaded periods to increase the C/N ratio and improve denitrification. (Agostine-PTT)
W91-04697

PERFORMANCE OF LABORATORY-SCALE UPFLOW ANAEROBIC SLUDGE BLANKET (UASB) REACTORS.
Roorkee Univ. (India). Dept. of Civil Engineering.
N. A. Khan, and I. Mehrotra.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 285-286, 1990. 2 fig, 3 tab, 1 ref.

Descriptors: *Activated sludge process, *Industrial wastes, *Sludge, *Wastewater facilities, *Wastewater treatment, Chemical oxygen demand, Mathematical studies, Organic loading, Wastewater reactors.

Experiments were designed to assess the performance of three laboratory-scale upflow anaerobic sludge blanket (UASB) reactors at different organic loading rates without desludging the reactors. The reactors were inoculated with sugar mill wastewater acclimatized granular sludge. These were fed with synthetic wastewater prepared by diluting sugarcane molasses in tap water. At each organic loading rate, reactors were operated until a pseudo-steady state (PSS) condition with respect to gas production and COD removal efficiency was attained. It may be pointed out that within the limits of operating loads, the performance of the reactor is independent of organic loading rate. In all cases the COD removal efficiency and gas production were in the range 90-95% and 0.39-0.45 cu-m/kg COD removed. A ratio of volume of sludge bed in reactor (v) and volume of reactor (V) were ascertained for limiting space loading. It is apparent from the data that the organic load is limited by space of the reactors once the sludge occupancy is (43+3)%(v/V). At the limiting value of v/V, it is quite likely that the sludge load (SLR) has not been fully utilized. It is therefore suggested that the reactors should be desludged to further increase the organic load. (Agostine-PTT)
W91-04698

PERFORMANCE INCREASE OF AEROBIC-BIOLOGICAL WASTE WATER TREATMENT PLANTS IN PAPERMILLS BY ANAEROBIC PRETREATMENT OF HIGH-STRENGTH PARTIAL FLOWS.
Papiertechnische Stiftung fuer Forschung und Ausbildung in Papiererzeugung und -Verarbeitung, Munich (Germany, F.R.). Wasser- und Abwasserforschungsstelle.
R. Huster, and C. H. Mobius.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 287-288, 1990. 1 fig, 2 ref.

Descriptors: *Aerobic conditions, *Anaerobic conditions, *Biological wastewater treatment, *Cost analysis, *Industrial wastes, *Pretreatment of wastewater, *Pulp and paper industry, *Wastewater facilities, *Wastewater treatment, Degradation, Flocculation, Germany, Mathematical studies, Pulp wastes.

To enhance operational safety and increase degradation performance of existing aerobic-biological plants, it is advisable in many cases to insert an anaerobic stage. Under a three-year research project conducted on a pilot-plant scale, effluents from mechanical pulp and waste paper pulp production (including the de-inking process) were tested for their anaerobic degradation ability. During these tests the hybrid process, a combination of a flocculent sludge upstream reactor in the lower section and a film reactor in the upper part, proved advantageous. This configuration provided for both acidification and methane fermentation in a single reactor. Performance increase calculations were made for existing aerobic-biological plants in papermills, their profitability being compared to that of plants including an additional aerobic stage. Costs for the aerobic process plus anaerobic pretreatment of the concentrated partial flows were compared to a purely aerobic treatment on an example of a papermill where about half of the effluent loads originate from higher-strength effluent partial flows. The computation does not take into account the cost advantages which might result from biogas production or the cost of sludge disposal. From a cost-saving aspect, both of these factors would favor a combined anaerobic-aerobic process. (Agostine-PTT)
W91-04699

STABILIZATION AND DISINFECTION OF SEWAGE SLUDGE BY TWO-STAGE ANAEROBIC THERMOPHILIC/MESOPHILIC DIGESTION.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
R. Mitsdorffer, W. Demharter, and W. Bischofsberger.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 289-298, 1990. 2 fig, 1 tab.

Descriptors: *Anaerobic conditions, *Biodegradation, *Disinfection, *Sludge treatment, *Wastewater facilities, *Wastewater treatment,

Bacteria, Germany, Salmonella, Thermophilic bacteria, Water quality standards.

The first equipment for two-stage anaerobic thermophilic/mesophilic digestion (55/35 C) of sewage sludge constructed in Germany in 1987 was investigated during the first year of large-scale operation. Two-stage thermophilic/mesophilic digestion is a process suitable for increasing capacity of stabilization and disinfection at the same time. Comparison at the same digestion plant indicate stabilization efficiency of this process is higher compared to conventional mesophilic operation at this plant. With temperatures ranging from 50-55 C and the hydraulic retention time being some 5 days, safe operation of the thermophilic predigestion stage is achieved leading to stable production of biogas. Efficiency of digestion is about 40% (COD,VSS). In total a specific gas production of 610 L/kg VSS and a degree of 66% reduction of VSS, respectively, is achieved by thermophilic/mesophilic digestion. By-passing the first stage leads to a significant decrease of stabilization efficiency. Disinfection of sewage sludge during thermophilic treatment in the first stage meets the demands of German legislation. Health risks which may arise from agricultural use of digested sewage sludge are eliminated completely during the thermophilic stage of digestion. Enterobacteriaceae and Salmonella, which are taken as indicators of health risk are reduced several orders of magnitude. (Agostine-PTT)
W91-04700

UPGRADING OF WASTEWATER TREATMENT PLANTS: OXIDATION PONDS IN SERIES WITH BIOLOGICAL FILTERS.
Meiring and Barnard CC, Box 28734, Sunnyside, 0132, Republic of South Africa.
P. G. J. Meiring, and J. A. van Huyssteen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 291-292, 1990. 1 fig.

Descriptors: *Biological wastewater treatment, *Filters, *Oxidation ponds, *Upgrading, *Wastewater facilities, *Wastewater treatment, Developing countries, Model studies.

In order to provide affordable and effective wastewater treatment facilities in the developing countries that can meet effluent quality standards, it is necessary to take into account the available electricity and the availability of skilled manpower. The progressive extension and sophistication of a treatment facility is proposed such that it will render an effluent of superior quality, but with relatively simple management requirements. A four stage process is described which would parallel population growth. The first stage, designed to serve 4000 people with a flow of 500 cu m/d, includes a 1.67 ha primary facultative oxidation pond, a 7500 cu m secondary pond volume and a grassbed area of 1 ha. The second stage is designed for 8000 people and a flow of 1000 cu m/d. This has a recirculation rate of 12 L/s and a grassbed area of 2 ha. In the third stage, designed for a population of 20,000 and a flow of 3250 cu m/d, are three 2500 cu m anaerobic ponds, two in series and one standby, a grassbed area of 6.5 ha, and a 20% recirculation of 6 L/s to prevent odor production. In the fourth stage the oxidation ponds may be operated in parallel with a recirculation rate of 38 L/s. (Agostine-PTT)
W91-04701

UPGRADING OF A WASTEWATER TREATMENT PLANT IN A WINTER TOURISM RESORT AREA BASED ON IN-STREAM STANDARDS.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
H. Fleckseder, K. Gotzendorfer, and G. Schnell.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 293-295, 1990. 5 ref.

Descriptors: *Model studies, *Seasonal variation, *Upgrading, *Wastewater facilities, *Wastewater treatment, *Water quality standards, Activated sludge process, Austria, Denitrification, Nitrification, Project planning.

A tourist resort area in the Austrian Alps is situated on a trout stream with a wintertime average low flow of 0.5 cu m/s. There are 7500 population equivalents (PE) of permanent inhabitants and peak seasons are estimated to have 30,000 PE (a ratio of 1:4). The yearly load thus varies within this ratio, with a sharp change in load to treatment around Christmas. Therefore, all conditions for nitrification and to some extent denitrification are quite unfavorable because of low winter temperatures. The present treatment plant was designed for carbon removal only and comprises primary settling, final sedimentation, sludge digestion and liquid storage of sludge at ambient temperature. A simulation model was used to develop a design procedure. The IAWPRC Activated Sludge Model was used to evaluate the design concept both for nitrification and denitrification. This program solves plug flow conditions for stirred tanks in series, i.e. which are much more favorable for bioconversion of dissolved substrates than a completely mixed tank alone. The reliability of the model increases with data available for model calibration and additional data for model verification. The approach presented shows that advanced effluent conditions can be met even in winter resort areas. However, as the values simulated do not hold any safety margin, designers should select somewhat larger volumes than shown in the simulation runs. The higher the ratio between off to on-season-loads, the more important the adaptation of nitrifiers to the higher load from an intermediate source becomes. (Agostine-PTT)
W91-04702

LINPOR-PROCESS FOR NITRIFICATION AND DENITRIFICATION.
Linde A.G., Hoellriegelskreuth (Germany, F.R.). Werksgruppe Tieftemperatur und Verfahrentechnik.
H. Reimann.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 297-298, 1990. 3 fig, 1 tab, 2 ref.

Descriptors: *Biological wastewater treatment, *Denitrification, *LINPOR process, *Nitrification, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Germany, Mathematical studies, Pilot plants.

LINPOR is the name for biological waste water treatment processes where the biomass grows inside open pore plastic foam cubes. It is a one step system which combines activated sludge or 'free biomass' with foam 'attached biomass'. According to the results of full-scale experience at the city of Freising, the biomass concentration can be raised to 2-3 times the usual values, and the sludge index of the free biomass is lowered if there are sludge bulking problems. At the Freising plant nitrification and denitrification were done simultaneously at fairly high volumetric loading. Long-term results of pilot and laboratory testing of nitrification and denitrification are given. The results indicate that the free and attached biomass are both active in BOD-degradation, nitrification and denitrification. Simultaneous denitrification can be attributed to an anoxic nucleus in the cubes (microelectrode measurement). The nitrification efficiency (excluding N-assimilation) in the combined system seems to be mainly controlled by the product of maximum aerobic growth rate for Nitrosomonas and sludge age. (Agostine-PTT)
W91-04703

BIOLOGICALLY INTENSIFIED FILTRATION PROCESSES (DRY BED FILTER) FOR AN EFFICIENT EFFLUENT IMPROVEMENT OF WASTEWATER TREATMENT PLANTS: APPLICATIONS.
Hanover Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft und Abfalltechnik.
A. Kraft, and C. F. Seyfried.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 299-300, 1990. 2 tab.

Descriptors: *Biological filters, *Biological wastewater treatment, *Effluents, *Filters, *Filtration, *Pulp and paper industry, *Wastewater facilities, *Wastewater treatment, Biochemical oxygen demand, Chemical oxygen demand, Cost analysis, Sedimentation, Suspended solids, Water quality standards.

As a consequence of stricter demands and elevated minimum requirements concerning purified wastewater, planning for enlargement of two wastewater treatment plants was pushed forward. The plants are a municipal wastewater treatment plant and one for a wastepaper processing firm. The municipal treatment plant consisted of an oil trap and a grit chamber, a primary sedimentation tank, and a highly-loaded activated sludge plant. Lower costs and considerably less space demand led to the application of a dry bed filtration process as the second biological purification stage, which was put into operation in 1986. In the dry bed filtration process, wastewater trickles through the filter bed and simultaneously air is sucked through it. With the use of dry bed filters elimination of solids is combined with biological activities. Besides an excellent elimination of suspended solids (77% on the average), a nitrification efficiency of up to 65% was observed. The wastewater treatment plant of the wastepaper processing industry consisted of a buffer tank, a coagulation stage and sedimentation. Since it was no longer able to maintain the required effluent values of BOD5 and COD, a biological stage was added. A comparison of possible alternatives with regard to investment costs, operating costs, and operating safety led to the application of a trickling filter/dry bed filter which was put into operation in 1985. In 1987, the filtration stage resulted in a BOD5 elimination of up to 88% and which averaged 73%. The COD reduction was up to 63% and averaged 57%. (Agostine-PTT)
W91-04704

UPGRADING OF WASTEWATER TREATMENT PLANTS USING PURE OXYGEN.
BOC Ltd., London (England). Environmental Processes.
F. J. Gould.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 301-302, 1990. 1 fig.

Descriptors: *Biological wastewater treatment, *Oxygen, *Oxygenation, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Dissolved oxygen, Effluents, England, Fish farming, Odor control, Oxidation.

The Vitox process has been developed as a high-rate aqueous oxygenation technique and has been used to upgrade existing biological treatment plants at numerous industrial and municipal sites. It consists of a pressurized sidestream where pure oxygen enters the recycle through a venturi injector positioned after the pump discharge. To date this technique has been used in many different applications in addition to upgrading activated sludge plants. Typical situations where it has been employed include fish farming, river oxygenation and odor control. When the oxygen process is applied to activated sludge, the overall treatment capacity can be increased and many plants in the UK are currently operating at between two and three times the original design capacity by using this process. The improved settling velocity of sludge is perhaps the most significant effect of operating the oxygen activated sludge process, since poor sludge settlement is frequently the limiting factor in the production of good quality final effluent. The improved settling can be attributed partly to the provision of a generally higher level of dissolved oxygen (DO) in the plant, but more importantly to the maintenance of a steady DO level at all times against a variable loading on the plant. The improved mixing due to the subsurface jets ensures a more uniform DO level throughout the treatment plant, thereby maintaining the best possible conditions for biological oxidation. In 1988 two full-scale effluent plants were designed and commissioned as purpose built open tank oxygen plants employing this technology. The designs included two and four ton/day units providing all the oxygen for the process and the necessary mixing energy. (Agostine-PTT)
W91-04705

UPGRADING OF KANPUR WASTEWATER TREATMENT PLANT BY PHASED EXPANSION.
Indian Inst. of Tech., Kanpur. Dept. of Civil Engineering.
M. Kulshrestha, A. Srivastava, C. Venkobachar, and S. Ramaseshan.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 303-304, 1990. 2 fig, 1 ref.

Descriptors: *Future planning, *India, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Aeration, Anaerobic digestion, Cost analysis.

The phased expansion of the treatment facility for wastewater produced by a part of Kanpur city is described. This envisages the decentralization of the treatment facility by locating smaller units in different locations along the banks of the Ganga (Ganges) River. The spot units are to be expanded in a phased manner to consistant with financial resources. The treatment facility proposed in the initial stages is the less capital intensive which will be converted to capital intensive activated sludge unit (ASU) at a later stage. The plan for the energy intensive EAAS which is converted at a later time to a capital intensive ASU with a provision for sludge treatment, effects a deferred capital investment. Two EAAS units of each 4 MLD capacity ar proposed for the year 1991 and an additional EAAS will be provided for second stage expansion in 2001 A.D. For the year 2020, two EAAS units of 4 MLD each would be converted to two ASU units to handle 8 MLD of wastewater each. At this stage anaerobic digestion will be incorporated to handle excess sludge from ASU which is not required with EAAS. (Agostine-PTT)
W91-04706

DESIGN OF A LOW STRENGTH SEWAGE TREATMENT PLANT IN A COLD CLIMATE.
Proctor and Redfern Ltd., Don Mills (Ontario).
B. Evans, J. Kempa-Teper, and K. Murphy.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 305-306, 1990. 3 tab.

Descriptors: *Activated sludge process, *Canada, *Design criteria, *Upgrading, *Wastewater facilities, *Wastewater treatment, Aeration, Biodegradation, Clarifiers, Computer programs, Effluents, Hydraulic loading, Model studies, Nitrification, Seasonal variation, Secondary wastewater treatment, Sludge drying, Water quality standards.

The city of Ottawa, the Capital of Canada, is currently upgrading the primary treatment plant to full secondary treatment using the conventional activated sludge (CAS) mode. The location is unique, having long winters with temperatures regularly below -20 C alternate with hot summers at 30 C. Lack of industrial development and a high standard of living, coupled with significant infiltration, result in a raw wastewater of low strength. The expansion was required because of new stringent effluent guidelines which were lowered from 39/31 g/cu m (BOD, SS) to 15/15/1 g/cu m (BOD, SS, Total P). In order to achieve these consistently (on a monthly average basis) it was decided to use the CAS mode of secondary treatment. Two key operating parameters which affected design were: (1) long spring runoff with low strength, high flow and cold temperatures, all of which can create a potential washout problem; and (2) high summer temperatures with low strength and a long hydraulic retention time, which introduces the potential of nitrification and its attendant problems. Six operating loads and flows were selected as representative of the potential design and operating limits of the plant. These scenarios were tested using a customized sewage-treatment plant design model (developed in-house) which runs on an IBM-compatible personal computer and uses the Lotus 1,2,3 software package. The design had to include sufficient operational flexibility, standby and redundancy of various unit operations to allow for good operation in the above-mentioned conditions. The final proposed design includes: (1) primary clarifiers (rectangular); (2) aeration tanks (diffused air); (3) secondary clarifiers (circular); (4) digesters; and (5) centrifuges (dewatering and thickening). (Agostine-PTT)
W91-04707

INFLUENCE OF UPGRADING OF WASTE WATER TREATMENT PLANTS ON THE DESIGN OF AERATION SYSTEMS.
Suprafilt G.m.b.H., Bietigheim-Bissingen (Germany, F.R.).
H. J. Schmidt-Holthausen.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 307-308, 1990.

Descriptors: *Aeration, *Aerators, *Design criteria, *Upgrading, *Wastewater facilities, *Wastewater treatment, Compressed air, Cost analysis, Energy use efficiency, Future planning, Germany, Oxygen demand, Pumps.

As almost 80% of the electric energy of a conventional wastewater treatment plant is consumed by the aeration system, it is of utmost importance that such system be designed to economically meet all future requirements. The flexibility of a wastewater aeration system depends on the types of aerators involved. As mainly fine bubble or surface aerators are used, the following conclusions will be restricted to these types. First, a good guess should be made as far as the future air quantities are concerned. The future oxygen demand can easily be calculated on the basis of the stoichiometric values. The air compression station, consisting either of rotary blowers or turbo-compressors, should be designed such that additional aggregates can easily be installed. It is advisable to these machines as flexible as possible; they should, for example, be equipped with variable speed motors. The compressors should be of the same size so that they can easily replace one another. The entire air piping system must be capable of transporting larger air quantities at a later time. Surface aerators can only change their oxygenation capacity by variation of circumferential speed and submergence. Thus, a total change of the aerators would be necessary, if the dimensions of the tanks allow this without a negative influence on the efficiency. Certain parameters such as specific energy per tank volume, tank width to water depth ratio and total aerated volume must be considered. It can be seen that it is almost impossible to design surface aerators to later meet greater oxygen demands. (Agostine-PTT)
W91-04708

IMPROVEMENT OF WASTEWATER TREATMENT PLANT PROJECTS.
Wyzsza Szkola Inzynierska, Zielona Gora (Poland).
E. S. Kempa.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 309-310, 1990.

Descriptors: *Construction costs, *Poland, *Project planning, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Aeration, Biodegradation, Case studies, Cost analysis, Diffusers.

The original designs of three Polish wastewater-treatment plants were found to be both too costly and too complicated. For this reason modified project plans were developed. The first two plants have been completed and have worked well for 10 or more years; construction of the third will start soon. Plant elements of the modified project for plant 1, a plant for flax retting and linen wastewaters, were: oil separator, screens, grit chamber, one equalizer, one primary settling tank, two aerated ponds of earth construction working in series, one secondary settling tank for activated sludge recycling, and the use of existing ponds as polishing ponds. The modified plan for plant 2, for domestic sewage from a rural area, included: screens, earth lagoons aerated with floating aerators, and having a detached non-aerated part for solids settling and for self-acting sludge recirculation, and aerobic sludge digestion in the same lagoons. The modified plan for plant 3, for municipal sewage from a combined sewer system, is the same as for plant 2, with the addition of a linear fine-bubble diffuser aeration system. The construction costs of these plants were 50 to 60% of those previously calculated for the unmodified plans. (Agostine-PTT)
W91-04709

WASTEWATER TREATMENT BY SOIL ABSORPTION SYSTEMS.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
T. Ebers, and W. Bischofsberger.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 311-312, 1990. 5 fig.

Descriptors: *Germany, *Infiltration, *Lysimeters, *Percolation, *Soil absorption systems, *Soil disposal fields, *Wastewater treatment, Aerobic conditions, Anaerobic conditions, Groundwater quality, Hydraulic loading, Moisture meters, Nitrification, Nutrient removal, Septic tanks, Soil properties.

In the Federal Republic of Germany, the barely treated wastewater of about 7 million people is percolated into the soil. Groundwater quality has now become a major concern, and the effectiveness of soil infiltration as a means of eliminating pollution from household wastewater is being investigated. Experiments with six laboratory lysimeters have been in operation for two years. Three lysimeters were filled with slightly silty sand, the other three with fine gravel sand. Initially they were loaded with mechanically treated wastewater from a municipal treatment plant and later with effluent from a septic tank. Hydraulic loading varied from 0.5 to 31 cm/d. Results showed good efficiency for fine gravel sand (aerobic conditions) in removal of BOD5 (98.0 to 99.2%), COD (88.0 to 92.8%), and Kjeldahl nitrogen (90.0 to 91.3%). Slightly silty sand (anaerobic conditions) showed the best results in elimination of phosphate (86.0 to 99.3%) and relatively good rates were achieved for BOD5 (65.0 to 98.2%) and COD (about 76%). Elimination of Kjeldahl nitrogen ranged from 39.6 to 68.4%. The results for the two soils can be summarized as follows: (1) Fine gravel sand--high hydraulic loading capacity (aerobic conditions), high elimination rates for BOD5, COD, ammonium by nitrification and very low elimination of total phosphate; (2) slightly silty sand--low hydraulic loading capacity and, despite this, anaerobic conditions; high elimination rates of BOD5 and barely inferior elimination rates of COD in comparison to fine gravel sand; low elimination rates of ammonium, very high elimination rates of total phosphate. (Author's abstract)
W91-04710

SUBSOIL PERCOLATION OF SEWAGE: PURIFICATION EFFICIENCY OF UNSATURATED ZONE AND MASS BALANCE OF ORGANIC LOAD.
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
S. Rettinger, and W. Bischofsberger.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 313-315, 1990. 3 fig, 2 ref.

Descriptors: *Aeration zone, *Fate of pollutants, *Mass balance, *Organic loading, *Path of pollutants, *Percolation, *Soil disposal fields, *Wastewater treatment, Biodegradation, Carbon, Heavy metals, Infiltration, Phosphorus, Seepage.

Special attention is being paid to the unsaturated zone because of its purification efficiency on discharges from septic tanks, leaking sewers, and seepage from agricultural lands. Since knowledge of quantitative effects and removal processes is poor, investigations were conducted using lysimeters and a full-scale soil-disposal system. The variation of soil water composition below sewage infiltration and natural rainwater percolation is very similar in DOC, ammonia-nitrogen, phosphorus and some heavy metals, but not in oxidized nitrogen. The removal and decomposition of these constituents happens within the short distance of approximately 1 meter. The subsoil infiltration of sewage into unsaturated gravel leads to biological growth, causing the decomposition of organic carbon. This depends on the organic load, soil temperature and oxygen supply and is proved by

high partial pressures of CO2 below the distribution pipe. The rate of diffusion for O2 and CO2, directly depending on the soil water content may be the limiting factor for biological decomposition. The variation of seepage-water constituents and mass balances and other data suggest the possibility of upgrading soil disposal systems to minimize soil and groundwater pollution. (Agostine-PTT)
W91-04711

REAL-TIME BIOLOGICAL PROCESS OPTIMIZATION USING OFF-LINE AND ON-LINE MONITORING.
CH2M Hill, Emeryville, CA.
J. Buttz, G. Daigger, and M. Robbins.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 317-318, 1990. 3 fig.

Descriptors: *Biological wastewater treatment, *Monitoring, *Optimization, *Process control, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Dye releases, Mathematical studies, Oxygen.

Beginning in early 1989, a series of special investigations at the Upper Occoquan Sewage Authority Regional Water Reclamation Plant were initiated to better characterize and optimize the performance of new secondary treatment facilities. Included in the investigation were: (1) flow pattern dye testing of secondary and chemical clarifiers; (2) characterization of aerobic selector performance; (3) stress testing of secondary clarifier solids removal; (4) on-line monitoring of the activated sludge treatment system, and (5) oxygen transfer efficiency testing of two aeration systems. The aerobic selector performed well in optimizing the settleability of the activated sludge. Substrate storage, not oxidation, was seen as the primary removal mechanism. Dye testing revealed good performance of mid-radius and horizontal weir baffles in optimizing clarifier performance. On-line sludge monitoring revealed diurnal variations in recycled activated sludge solids concentrations. These variations should be considered in calculating waste sludge amounts. A direct effect between influent flow rates and secondary effluent suspended solids was seen in the on-line data. Depressed dissolved oxygen levels were linked by on-line monitoring to elevated effluent ammonia levels. Secondary process ammonia removal was optimized by maintaining DO concentrations at 2 mg/L or above. (Agostine-PTT)
W91-04712

METAL REMOVAL BY WASTE BIOMASS TO UPGRADE WASTEWATER TREATMENT PLANTS.
Indian Inst. of Tech., Kanpur. Dept. of Civil Engineering.
C. Venkobachar.
Water Science and Technology WSTED4, Vol. 22, No. 7/8, p 319-320, 1990. 3 fig.

Descriptors: *Biological wastewater treatment, *Biomass, *Heavy metals, *Upgrading, *Wastewater facilities, *Wastewater treatment, Activated sludge process, Chromium, Copper, Fungi, Industrial wastewater, Pretreatment of wastewater, Titration, Water quality standards.

Biosorption as a pretreatment was evaluated for its ability to remove heavy metals from electroplating and chrome tannery effluents, before these are mixed with domestic wastewater for biological waste treatment. The biosorptive capacities of Cu(II) and Cr(VI) by waste biomass, such as excess sludge from an activated sludge unit, Ganoderma lucidum, (a wood-rotting fungus), and Asperigillus niger from the fermentation industry, were evaluated. The biosorbents were sun-dried and pulverized to a mean size of 100 microns. The ability of biosorbents to absorb Cu(II) at different pH values was determined. The protons released during sorption by fungus were estimated by back-titrating the reaction mixture to the original pH. Results indicate the optimum pH for removal of Cu(II) is 5.0. G. lucidum exhibited rapid and more sorptive capacity for Cu(II) than sludge or A. niger. Cu(II) removal is by ion exchange and Cr(VI) removal by electrostatic attraction by the fungus. (Agostine-PTT)
W91-04713

EFFECT ON MINERAL MEDIA ON TRICHLOROETHYLENE OXIDATION BY AQUIFER METHANOTROPHS.
Stanford Univ., CA. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5B.
W91-04730

TRANSFORMATION OF INDOLE BY METHANOGENIC AND SULFATE-REDUCING MICROORGANISMS ISOLATED FROM DIGESTED SLUDGE.
Pennsylvania State Univ., University Park. Lab. of Soil Biochemistry.
For primary bibliographic entry see Field 5G.
W91-04731

RETROSPECTIVE COHORT MORTALITY STUDY OF CANCER AMONG SEWAGE PLANT WORKERS.
State Univ. of New York at Buffalo. School of Medicine.
J. Lafleur, and J. E. Vena.
American Journal of Industrial Medicine AJIMD8, Vol. 19, No. 1, p 75-96, 1990. 5 tab, 33 ref.

Descriptors: *Cancer, *Carcinogens, *Human diseases, *Wastewater facilities, Cancer risk, Chemical sludge, Chemical wastewater, Chemicals, Mortality, Occupations, Wastewater.

There is little known about the incidence of cancer among sewage workers. Findings from a retrospective cohort study of 487 white male sewer authority workers employed between January 1950 and October 1979 were examined. Vital status was ascertained for 93% of the cohort yielding a total of 6886 person years. Total mortality from all causes was comparable to that of the general white male U.S. population. The cohort was subdivided into those not exposed, and sewer workers who were exposed to sewage effluent, sludge, or wastewater containing chemicals including potential carcinogens. Among the nonexposed group, mortality from all causes was significantly low. Among the exposed sewer workers, mortality from all causes was not significantly different from that of the general white male U.S. population. Mortality from all cancers among exposed sewer workers was slightly higher than that of the general population. Statistically significant elevated mortality ratios were seen for cancer of the larynx and cancer of the liver. Careful study of the medical and occupational histories of these cases suggested that larynx cancer was possibly work-related, while liver cancer was not. A group estimated to be the highest exposed, composed predominantly of operatives, had a higher directly adjusted death rate from all malignant neoplasms combined compared to all other workers. These findings of increased risk of cancer among exposed sewage workers, especially operators, are based on a small number of cases and should be interpreted with caution. Studies of larger cohorts are needed to clarify the risk of these cancers among sewage workers. (Author's abstract)
W91-04754

THEORY AND PERFORMANCE OF A JET-MIXED SEPARATOR.
Miyazaki Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-04757

WASTE WATER TREATMENT USING SALINE CULTURES OF MICROALGAE.
Chile Univ., Santiago. Dept. de Fisica.
J. Toha, M. A. Soto, and X. Cuadros.
Biotechnology Techniques BTECE6, Vol. 4, No. 6, p 441-444, November/December 1990. 3 fig, 2 ref.

Descriptors: *Algae, *Biological wastewater treatment, *Saline water, *Wastewater treatment, Algae harvesting, Algal control, Disinfection, Hydrogen ion concentration, Seawater.

A salt concentration over 1% is harmful to many bacteria. Nevertheless, there are marine bacteria found in the Dead Sea and other places where salinity reaches 29%. Studies on stabilization ponds used to treat wastewater show that the most probable cause of microbial mortality in these ponds is the pH increase caused by the development of microalgae and its active photosynthesis. A pH of over 9 drastically reduces the presence of bacteria in water. The treatment of wastewater in places near the ocean was analyzed. A combination of sea water salinity obtained from a mixture of wastewater and sea water and the action of microalgae cultures able to grow in a saline medium, inducing a high pH, was examined. The survival of Escherichia coli C at different NaCl concentrations, with and without the presence of Dunaliella or Aphanotace algae was studied. In this system, the cooperative action of salinity and high pH on bacterial damage and the possible practical use of alga biomass and its by-products for industrial uses was taken advantage of. From the results, the microbial mortality observed in algae cultures can be attributed principally to changes in the pH. If a high pH is critical for the efficient operation of stabilization ponds, this condition can be accelerated by a rapid increase of the algae population in the stabilization pond, by means of an algae transfer from another complementary well-populated culture. In this process, Dunaliella were bred in optimum conditions in a first pond. The microalgae were concentrated in the tank overnight via light attraction. In the morning, the concentrated alga, suspended in saline water were poured into the wastewater pond in which, in the course of the day, the abundant active alga promote a rapid increase of the pH. At night, or on the following night after the wastewater treatment has been carried out, the algae are recovered in the intermediate tank again using the light as attractor. The next morning the algae are poured into the original algae growing pond where breeding continues while the treated wastewater is drained from the other pond. (Mertz-PTT)
W91-04762

EFFECT OF OXIDANTS ON UV DESTRUCTION OF CHLOROPHENOLS.
National Taiwan Inst. of Tech., Taipei. Dept. of Chemical Engineering.
Y. Ku, and S. C. Ho.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 218-221, November 1990. 10 fig, 1 tab, 10 ref. Energy Committee-Ministry of Economic Affairs, Republic of China contract 782T1.

Descriptors: *Biological wastewater treatment, *Halogenated hydrocarbons, *Ultraviolet radiation, *Wastewater treatment, Biodegradation, Dissolved oxygen, Hydrogen ion concentration, Oxidation, Phenols.

Halogenated aromatics which are often present in industrial wastewaters, are very difficult to remove by conventional biological treatment processes because many of them are resistant to biodegradation. Various physicochemical techniques have been developed for the removal of halogenated aromatics from wastewaters. Ultraviolet treatment application for the destruction of nonbiodegradable chlorophenols with the presence of different oxidants was examined. The experiments were carried out in a batch photoreactor under various pH, dissolved oxygen time, and oxidant types and concentrations. Experimental results indicate that the dissolved oxygen levels have little effect on the destruction of chlorophenols by ultraviolet irradiation. The presence of some oxidants (for example, H2O2) significantly increased the destruction efficiencies of chlorophenols by ultraviolet treatment. For the ultraviolet/H2O2 process, the rate expression was developed empirically and found to be pseudo-first order with respect to the concentration of phenols. Proper reactor design is essential to the successful application of ultraviolet/oxidant treatment. (Mertz-PTT)
W91-04766

HOMOGENEOUSLY CATALYZED OXIDATION FOR THE DESTRUCTION OF AQUEOUS ORGANIC WASTES.
Tulsa Univ., OK. Dept. of Chemical Engineering.
D. D. Leavitt, J. S. Horbath, and M. S. Abraham.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 222-228 , November 1990. 10 fig, 5 tab, 9 ref.

Descriptors: *Industrial wastewater, *Organic compounds, *Oxidation, *Wastewater treatment, Acids, Ammonium, Atrazine, Carbon dioxide, Heavy metals, Kinetics, Metal complexes.

Oxidation of organic materials to CO2 and water provides a suitable means of reducing the toxicity of many waste products. These wastes may be present in water, solids, or in air, typically as complicated mixtures of many components within a solvent stream. Several organic species, specifically atrazine, 2,4-dichlorophenoxyacetic acid, and biphenyl, were converted to CO2 and other nonharmful gases through oxidation catalyzed by inorganic acid. Nearly complete conversion was obtained through homogeneous liquid-phase oxidation with ammonium nitrate. The kinetics of reaction have been investigated and indicate parallel oxidation and thermal degradation of the oxidant. This results in a maximum conversion at an intermediate temperature. Increasing oxidant concentration accelerates the rate of conversion and shifts the location of the optimum temperature. Reaction at varying acid concentration revealed that conversion increased with an approximately linear relationship as the pH of the solution was increased. Conversion was increased to greater than 99% through the addition of small amounts of transition metal salts demonstrating the suitability of a treatment process based on this technology for wastestreams containing small quantities of heavy metals. (Mertz-PTT)
W91-04767

HETEROGENEOUS PHOTOCATALYSIS FOR WATER PURIFICATION: CONTAMINANT MINERALIZATION KINETICS AND ELEMENTARY REACTOR ANALYSIS.
North Carolina State Univ. at Raleigh. Dept. of Chemical Engineering.
D. F. Ollis, and C. Turchi.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 229-234, November 1990. 8 fig, 15 ref.

Descriptors: *Industrial wastewater, *Photolysis, *Wastewater treatment, Destructive technologies, Ozonation, Peroxidation, Photocatalysis, Ultraviolet radiation.

The environmental pressures of the decade have produced a technology development trend in wastewater treatment which is away from phase transfer approaches and toward destructive technologies. Two desirable goals are accomplished by such technologies: the resultant water is decontaminated so that it may be discharged in suitable fashion, and the potential liability arising from the original contaminant is destroyed. Heterogeneous photocatalysis is the third and newest of a emerging series of photolytic technologies for treatment and purification. Ultraviolet ozonation and ultraviolet peroxidation are technologies that involve direct photoactivation of the contaminant and/or dissolved oxidant and are dominated by solution phase chemistry. Photocatalysis, in contrast, involves photoactivation of the heterogeneous catalyst (an example of indirect photochemical processes) and is dominated by reaction events initiated at the catalyst surface. Heterogeneous photocatalysis has been extended recently to examine more closely the relevance of kinetic and reactor design to situations of particular interest for oxidative destruction of water contaminants. These situations include: prediction of the entire time course of a reaction; demonstration that rate parameters derived from examination of single compound photocatalyzed conversions can be used to provide reasonable estimates of reactor performance while operating with multicomponent feed streams; demonstration that reasonably simple design equations can be used to describe photoreactors with a variety of flow fields and various degrees of axial and lateral mixing; and demonstration that such equations could be extended to describe multiple kinds of photoinitiated chemistry to predict the relative importance of the various photochemistries to overall reactor performance. (Mertz-PTT)
W91-04768

ELECTROSORPTION: A CASE STUDY ON REMOVAL OF DILUTE ORGANICS FROM WATER.
Union Carbide Chemicals and Plastics Co., Inc., South Charleston, WV. Technical Center.
R. S. Eisinger, and G. E. Keller.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 235-244, November 1990. 7 fig, 4 tab, 12 ref.

Descriptors: *Electrosorption, *Organic compounds, *Saline water, *Wastewater treatment, Adsorption, Desorption.

One of the more difficult and expensive chemical separations faced in the chemical industry is removal of organics from salt-containing solutions. The separation can be accomplished by first separating the liquid phase from the salt, as by evaporation or recrystallization. However, this step is energy-intensive and expensive, and is especially difficult to justify when relatively low concentrations of organics must be removed from solution. Electrosorption, or potential-swing adsorption, appears well-suited for recovery of dilute organic compounds from ionically conductive solutions. The feasibility of using electrosorption in an industrially difficult separation, removal of ethyleneamines from a brine stream, was assessed. The assessment included lab-scale measurements using the model compound ethylenediamine, paper design of a commercial-scale process, and economic evaluation. Separation is achieved by periodically swinging the electrochemical potential on an adsorbent to achieve cycles of adsorption and desorption. Adsorption of ethylenediamine on activated carbon increased threefold following a change in potential of 1 volt. Adsorption increased at more negative potential, suggesting an acid/base-type effect at the carbon surface. The key to scale-up is use of relatively thin adsorbent beds to minimize time required to swing the potential. A design featuring stacked, 2-cm-thick layers of adsorbent separated by ion exchange membranes is proposed. The estimated cost of a electrosorption-based process to reduce ethyleneamines concentration from 220 parts per million to less than 60 parts per million would be several fold the value of recovered ethyleneamine. However, when employed for environmental reasons, cleanup by electrosorption would be economically attractive relative to alternate separation techniques. (Mertz-PTT)
W91-04769

USE OF PERVAPORATION FOR THE REMOVAL OF ORGANIC CONTAMINANTS FROM WATER.
Zenon Environmental, Inc., Burlington (Ontario).
For primary bibliographic entry see Field 5F.
W91-04771

TREATMENT OF ORGANIC-CONTAMINATED WASTEWATER STREAMS BY PERVAPORATION.
Membrane Technology and Research, Inc., Menlo Park, CA.
J. G. Wijmans, J. Kaschemekat, J. E. Davidson, and R. W. Baker.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 262-268, November 1990. 10 fig, 3 tab, 6 ref.

Descriptors: *Industrial wastewater, *Membrane filters, *Pervaporation, *Solvents, *Wastewater treatment, Hazardous materials, Hydrophobic compounds, Industrial wastes, Organic compounds, Separation techniques, Solvent recovery, Volatile organic compounds.

Pervaporation is a membrane process in which a permselective membrane is used to separate mixtures of dissolved solvents. The removal and recovery of organic contaminants from aqueous streams by pervaporation membrane systems is a viable and economical treatment for many waste streams. Three broad areas of industrial application have been identified as good opportunities for the technology: pollution control of dilute solutions of hydrophobic solvents; solvent recovery from process wastewaters; and volume reduction of mixed-solvent hazardous waste streams. The process is particularly suited to the treatment of water containing relatively hydrophobic volatile organics such as chlorinated solvents, naphthas, toluene, benzene and the like. Industrial demonstration of the technology is underway. (Mertz-PTT)
W91-04772

FEASIBILITY OF USING ALGINATE TO ABSORB DISSOLVED COPPER FROM AQUEOUS MEDIA.
California State Univ., Long Beach. Dept. of Chemical Engineering.
L. K. Jang, W. Brand, M. Resong, W. Mainieri, and G. G. Geesey.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 269-274, November 1990. 6 fig, 2 tab, 17 ref. NSF grants CBT-8721943 and ECE-8701462.

Descriptors: *Alginate, *Copper, *Heavy metals, *Industrial wastewater, *Wastewater treatment, Absorption, EDTA, Fluidized bed process, Ion exchange, Metals.

Alginate (a biopolymer from kelp and some bacterial strains) is known to absorb copper favorably in the presence of other cations. The feasibility of using a 2-liter batch three-phase (air/liquid/alginate gel) loop fluidized bed reactor to polish water containing 10-150 parts per million (ppm) dissolved copper was investigated. Three methods were tested: (1) Calcium alginate spheres, prepared by dispensing sodium alginate (3.2 % by weight in water) into a 0.5 molar calcium nitrate solution, were used as the absorbent; (2) the alginate spheres were formed in situ by dispensing the sodium alginate solution direction into the reactor fluid, and (3) procedures for experiment 2 were used except that a trace amount of EDTA was added to the alginate solution. Batch absorption data showed that the third method (using the EDTA) yielded the best result; the concentration of dissolved copper was successfully reduced from 140 ppm to 10 ppm with 3.2 g sodium alginate and 0.2 g EDTA used. However, when the initial concentration was below 40 ppm, both the second and third methods were not recommended because the concentration of dissolved copper was too low to allow in situ formation of alginate spheres. Method 1 was found to be useful for treating water containing 10 ppm dissolved copper but the competition from calcium seriously affected the effective capacity of the alginate for copper. The rate of absorption can roughly be described by the classical shell progressive model of reactive ion exchange. (Mertz-PTT)
W91-04773

PASSIVE TREATMENT TECHNOLOGY CLEANS UP COLORADO MINING WASTE.
Camp, Dresser and McKee, Inc., Denver, CO.
For primary bibliographic entry see Field 5G.
W91-04813

TURKEY CONFRONTS POLLUTION OF IZMIR BAY.
Black and Veatch, Kansas City, MO.
For primary bibliographic entry see Field 5G.
W91-04814

DESIGN OF A CHLORINATION/DECHLORINATION AND POST-AERATION FACILITY.
Kidde Consultants, Baltimore, MD.
N. A. Berman.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 24, 26-27, December 1990.

Descriptors: *Chesapeake Bay, *Chlorination, *Industrial water, *Maryland, *Wastewater facilities, *Wastewater treatment, *Water reuse, Aeration, Dechlorination, Disinfection, Gravity flow, Water quality.

The Back River (Maryland) Wastewater Treatment Plant's new chlorination/dechlorination and post-aeration facility is helping to improve water quality in the Chesapeake Bay. Although this operation is similar in configuration to most chlorination/dechlorination facilities, it is atypical in two main aspects. The first is the facility's exceptional size, which is required to process an average flow of 170 million gallons per day. The second is the distribution pattern, which provides up to 120 million gallons per day of chlorinated wastewater to Bethlehem Steel Corporation in Baltimore County, Maryland. The disinfection building contains the chlorination/dechlorination equipment, air padding, process control, and flushing-water systems. The chlorination system is composed of four 10,000-pound/day evaporators and chlorinators, each capable of producing a 15-mg/L chlorine solution at 310 gallon/minute. This system's flexible design simultaneously provides chlorine solution at various dosage to the chlorination tanks' mixing bay, the Bethlehem Steel Corporation pump station, and the aeration basins. To achieve the discharge dissolved oxygen requirement of 5 mg/L, project planners considered fine and coarse bubble diffusers and static mechanical aerators before settling on step aeration. The final design is a 5-step, 180-foot gravity cascade structure, which eliminated the planned supplemental mechanical aeration system. One of the most distinctive features of the chlorination/dechlorination facility is the Bethlehem Steel Corporation pump station. Because of the location of the chlorination/dechlorination and post-aeration facility, which is lower in elevation than existing facilities, a lift box or pumping station was required to meet the minimum flow requirements. Using gravity, gravity enhanced by pumping, or both, a configuration of pipes and valves permits delivery of chlorinated effluent for use as industrial water. (Mertz-PTT)
W91-04815

BILATERAL WASTEWATER LAND TREATMENT RESEARCH.
Robert S. Kerr Environmental Research Lab., Ada, OK.
L. E. Leach, B. E. Bledsoe, D. Zhen-Bo, and W. Shao-Tang.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 36-41, December 1990. 1 fig, 3 tab.

Descriptors: *China, *Infiltration, *Land treatment, *Wastewater treatment, *Water pollution prevention, *Water reuse, Environmental effects, Industrial water, Land disposal, Research, Urban areas, Water pollution, Water shortage, Wetlands.

Industrial and economic development has been occurring so fast in China that severe imbalance in the available water supply, water use, and wastewater treatment has occurred in many areas. Far more attention is now being paid to finding solutions for environmental pollution throughout China, particularly in water-short metropolitan regions such as Beijing. A variety of methods is needed to solve the problems of water shortage and water pollution control in the Beijing region. The success of the bilateral land treatment research studies has prompted Chinese environmental officials to endorse land treatment technology for universal application throughout China. Short-term demonstration studies initiated in 1988 investigated eight key projects located in five provinces. These include a fast-track evaluation of rapid infiltration, slow rate, overland flow, and constructed wetland systems. The treatment evaluations were targeted for completion by the end of 1990. These eight key projects provided operating and design variables for full-scale systems tailored to the unique environmental and agricultural limitations of their various geographic localities. Construction of full-scale systems is slated for 1991. (Mertz-PTT)
W91-04816

TAMSHUI RIVER CLEANUP.
K. M. Yao.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 45-46, December 1990.

Descriptors: *Cleanup, *Nonpoint pollution sources, *Taiwan, *Tamshui River, *Wastewater treatment, *Water pollution control, *Water pollution sources, *Water quality control, Environmental protection, Incineration, Industrial wastewater, Landfills, Municipal wastewater, Wastewater facilities, Water pollution, Water quality, Water quality management, Water treatment.

The Tamshui River Basin, situated in the northern part of Taiwan, comprises the city of Taipei, its surrounding highly urbanized areas, and mountainous upland. The basin has an area of 2726 sq km and a population of over 5 million. The Tamshui is the second largest river system on the island with an average annual flow of 6592 million cu m. As a result of high population concentration and intensive industrial and agricultural development in the basin, the water quality of the river system has been severely affected, especially in the dry, warm summer months. The main point sources of water pollution are 5,486,000 people, 420,000 pigs, and 782 factories with a liquid effluent containing 10 kg/day of biological oxygen demand or more. In 1988, the government initiated a comprehensive scheme to clean up the river system. One major obstacle for such a cleanup effort was the grossly underdeveloped public wastewater facilities. Current water-quality goal for the cleanup scheme is to eliminate odor nuisance by 1991 and to achieve water quality levels in compliance with the water quality standards of the designated river classifications by 1995. Because household wastewater is the chief source of pollution, sewer and wastewater facility construction is to be undertaken at an accelerated pace. For wastewater from industries and pig farms, a two-prong abatement approach will be used. The environmental protection agencies will intensify compliance monitoring of effluent discharges and the agencies concerned with industrial and agricultural development will provide technical assistance. For the elimination of floating solid wastes, two regional incinerators and several regional sanitary landfill sites will be developed. In addition, land adjacent to the river banks will be developed into parks, walkways, and other recreational facilities. (Mertz-PTT)
W91-04818

GRAVITY BELT THICKENING AND LIME STABILIZATION.
EIMCO Process Equipment Co., Salt Lake City, UT.
For primary bibliographic entry see Field 5E.
W91-04820

IRVINE RANCH'S APPROACH TO WATER RECLAMATION.
Irvine Ranch Water District, CA.
J. Parsons.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 68-71, December 1990.

Descriptors: *California, *Irrigation programs, *Reclaimed water, *Wastewater renovation, *Wastewater utilization, *Water reuse, Domestic water, Irrigation districts, Irrigation practices, Irrigation water, Municipal water, Water resources management.

The increasing demands for water have thrust water reclamation practices to the forefront of water and wastewater system planning efforts throughout the world. Because of skyrocketing populations and limited water resources, water and wastewater districts in Southern California received early lessons on the importance of a careful, organized, and comprehensive approach to the successful design and implementation of water reuse systems. The Irvine Ranch Water District serves an area of about 72,000 acres and an existing population of 100,000 people. The district provides potable water service, treats and disposes of wastewater, and also distributes irrigation water for landscape and agricultural uses. The heart of the district's dual distribution system is the irrigation system which contains the network of pipelines that distributes reclaimed water to its users. The irrigation system provides water for three different uses. Landscape users including parks, schools, street median strips and homeowner associations are one group of users. Reclaimed water is most frequently directed for agricultural purposes. The third set of users includes high-rise buildings. This system, now in development, will use reclaimed water for toilets, urinals, and trap drains. The Irvine Ranch Water District uses guidelines developed in a joint effort between the local health departments. Guidelines include: irrigate between the hours of 9:00 pm and 6:00 am; irrigate in a manner that minimizes runoff pooling and ponding; adjust spray heads to eliminate overspray onto areas not under control of the customer; monitor and maintain the system; educate all maintenance personnel concerning the use of reclaimed water; and obtain approval for changes and modifications made to on-site facilities. (Mertz-PTT)
W91-04821

FLORIDA'S REUSE PROGRAM PAVES THE WAY.
Florida State Dept. of Environmental Regulation, Tallahassee.
D. W. York, and J. Crook.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 72-76, December 1990. 2 tab, 3 ref.

Descriptors: *Florida, *Public policy, *Reclaimed water, *Water policy, *Water reuse, Consumptive use, Groundwater quality, Irrigation programs, Irrigation water, Permits, Urban areas, Water conservation, Water supply, Water treatment.

Florida is different from the major reuse states in the semi-arid southwest U.S. In Florida, it rains an average of 54 inches/year and the state has abundant groundwater resources. However, almost 79% of Florida's 13 million people live near the coast and continued population growth is expected. These coastal growth areas are served primarily by shallow aquifers that are most vulnerable to overdraft and saltwater intrusion. Beginning in 1987, the Florida Department of Environmental Regulation embarked on an ambitious program designed to facilitate and encourage reuse of reclaimed water. The states water policy allows water management districts to require reuse outside of critical water-supply problem areas if reclaimed water is readily available to the applicant for a consumptive-use permit. Amendments to the rule modified high-level disinfection requirements to reflect existing technology and experience. Provision for limited wet-weather discharge were added to facilitate discharge of reclaimed water during wet-weather, high-flow periods when demand for reclaimed water normally is reduced. The Reuse of Reclaimed Water and Land Application rule was adopted in 1989. This rule provided detailed requirements for the design and operation of reuse projects in public access areas, including irrigation of lawns, parks, and golf courses, as well as irrigation of edible food crops. The Florida Department of Environmental Regulations strongly supports reuse of reclaimed water. The goal is to increase the amount of reuse in Florida by 40% above 1987 levels by 1992. (Mertz-PTT)
W91-04822

ECONOMIC TOOL FOR REUSE PLANNING.
Milliken Chapman Research Group, Inc., Littleton, CO.
J. G. Milliken.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 77-80, December 1990. 2 ref.

Descriptors: *Cost-benefit analysis, *Economic aspects, *Water resources management, *Water reuse, Cost analysis, Marketing, Reclaimed water, Water distribution, Water resources, Water treatment.

If cost-effectiveness, cost/benefit, and financial feasibility analyses and a market research pricing study are conducted, many of the key questions faced in water-resource planning can be answered. The various costs and effects can be arrayed together to help planners choose among the competing alternatives. Once an alternative is selected, a true cost/benefit analysis should be conducted. The most significant economic factors impacting

future potable and non-potable water reuse show trends that favor the future expansion of both potable and non-potable reuse. Factors requiring expenditures include: capital facility costs; operation costs to collect wastewater effluent; operating costs associated with treating the wastewater; and transportation costs. Savings can be found in reuse systems when some treatment costs can be avoided due to the fact it takes less treatment to meet pollution control requirements. Because available supplies are being used there are also savings in water supply acquisition costs. Revenues can be made through reused water sales. (Mertz-PTT)
W91-04823

SEWAGE SYSTEM IMPROVEMENT BY OPERATIONAL PARAMETERS RESEARCH.
Companhia de Saneamento Basico do Estado de Sao Paulo (Brazil).
L. Rodriques Alonso, R. J. da Costa e Silva, and F. J. Falcao Paracampos.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 81-83, December 1990. 2 fig, 3 tab.

Descriptors: *Brazil, *Municipal wastewater, *Sewer systems, *Wastewater facilities, Hydrograph analysis, Pollution load, Sewer hydraulics, Urban areas, Wastewater disposal, Water conveyance, Water demand, Water flow.

The Metropolitan Region of Sao Paulo, Brazil, has 15.5 million inhabitants. Approximately 90% of this population is served by water-supply systems, but only 50% has sewerage services. Lack of investment during the past decades has caused a huge gap in wastewater treatment that required attention. A monitoring program was established to determine the region's sewerage needs. The four objectives of this program were: to investigate the performance of specific areas and types of urban development (residential, commercial, and industrial) to provide information for the design of treatment plants and intercepting sewers, as well as the augmentation of existing systems; to study the flow variation in collecting and intercepting sewers to observe their hydraulic functions and reveal the need for additional districts; to collect information on pollutant loads; and collect information on the wastewater characteristics and source area to allow definition of control points and priorities. Single samples were collected from control points of selected district. Data included information from the precipitation gages and rainy-day hydrographs from the control points, flow data along the conveyance system, and the possible variations in the registered results. Hydrographic analyses were grouped by rainy or dry season and were compared. Daily per capita flow varied between 164 and 2855 L/inhabitant. Wastewater flow varied from 0.007 to 0.013 L/second for households. Wastewater characteristics such as biochemical oxygen demand, chemical oxygen demand, total solids and pH appeared light. (Mertz-PTT)
W91-04824

DESIGN MANAGEMENT KEEPS BOSTON'S WASTEWATER PROGRAM ON TRACK.
Metcalf and Eddy, Inc., Charlestown, MA.
J. A. Lager, and E. R. Locke.
Public Works PUWOAH, Vol. 121, No. 13, p 32-34, December 1990.

Descriptors: *Boston, *Boston Harbor, *Design criteria, *Massachusetts, *Wastewater facilities, *Wastewater treatment, Construction, Costs, Secondary wastewater treatment, Water pollution control.

Forty-three cities and towns in eastern Massachusetts send their wastewater to two primary sewage treatment plants that together discharge 460 mgd of poorly treated wastewater into the harbor. In 1984, the Massachusetts Water Resources Authority (MWRA) was vested with independent powers to provide wholesale water and sewer services to eastern Massachusetts and to bring these systems into compliance with environmental laws. The new facility that has been planned will replace two aging primary plants, one on Deer Island and one on Nut Island, with a single primary and secondary treatment complex on Deer Island. A peak capacity of nearly 1.3 bgd will make this the second-largest wastewater treatment operation in the U.S. When completed in 1999, the new plant will remove more than 85% of suspended solids and organic matter from Boston's wastewater. Meanwhile, a pilot of the secondary plant has consistently performed at 95% removal levels, a 300% improvement over today's removal rates. Design considerations have included: (1) extensive tunnel construction; (2) low-head turbines for power generation; (3) odor control; (4) noise control; (5) site grading; and (6) mitigating construction traffic. A large part of the design management program required the coordination of many designers and construction contractors, and in helping to control a $6.1-billion budget and fast-track schedule. It will be necessary to develop standards and manage interdependencies among dozens of agencies and contractors in order to create a plant that looks and works as if it were designed by a single firm. (White-Reimer-PTT)
W91-04846

MULTIPURPOSE STORMWATER DETENTION PONDS.
Wright Water Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 4A.
W91-04851

AROMATIC POLYAMIDE HYDRAZIDE MEMBRANES FOR REVERSE OSMOSIS SEPARATIONS.
Bhabha Atomic Research Centre, Bombay (India). Desalination Div.
For primary bibliographic entry see Field 3A.
W91-04906

PERVAPORATION OF AQUEOUS ETHANOL MIXTURES THROUGH POLY(DIMETHYL SILOXANE) MEMBRANES.
Manhattan Coll., Bronx, NY. Dept. of Chemical Engineering.
C. S. Slater, P. J. Hickey, and F. P. Juricic.
Separation Science and Technology SSTEDS, Vol. 25, No. 9/10, p 1063-1077, July/August 1990. 8 fig, 25 ref.

Descriptors: *Ethanol, *Industrial wastewater, *Membrane processes, *Permselective membranes, *Pervaporation, *Wastewater treatment, *Water treatment, Biochemistry, Biotechnology, Chemical treatment, Permselectivity, Pressure, Temperature.

Pervaporation is a relatively new membrane technology with great potential for utilization in the traditional chemical industry as well for biochemical and environmental engineering. In the fields of water purification and industrial and hazardous wastewater treatment, pervaporation can be utilized to remove trace organics. The parameters affecting the selective separation of ethanol through pervaporation membranes have been studied. A bench-scale system was used in conjunction with a poly(dimethyl siloxane) (PDMS) membrane. Three experimental studies consisting of the variation of temperature, downstream pressure, and feed concentration were investigated. These studies were designed to optimize pervaporation as well as to determine its limits. Variation of the flux with the process parameters was seen in all three studies. The flux increases with increasing temperature in an Arrhenius-like relationship. The pressure study showed a decrease in flux with increasing downstream pressure. The flux had a slight exponential increase with increasing feed concentration. Selectivity was not greatly affected by temperature, and it was observed to increase slightly. The downstream pressure has little effect on selectivity in the range < 30 torr. Although permeate concentration increases with increasing feed concentration, the selectivity decreases to unity. It has been shown that the membrane is most selective at lower feed concentrations. Based on the data obtained for a 5% ethanol feed concentration, the optimal conditions for permeation occur at the highest temperature and lowest permeate pressure, 90 C and 1 torr, where the flux was 1906 g/sq m/hr and the selectivity was 9. The maximum selectivity for a 5% feed mixture appears to occur at approximately 50 C, yielding a value of 10.5. The commercial application potential for this type of separation is biggest in environmental and biochemical engineering fields because of the low concentrations of solutes to be removed. (Lantz-PTT)
W91-04907

5E. Ultimate Disposal Of Wastes

UIC CLASS IV-V WELL SURVEY IN MAINE: INVENTORY, ASSESSMENT AND COMPLIANCE.
Maine Dept. of Educational and Cultural Services, Augusta.
M. R. James, and A. J. Pisanelli.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 215-236. 4 append.

Descriptors: *Databases, *Groundwater management, *Injection wells, *Maine, *Regulations, *Surveys, *Waste disposal wells, *Water pollution sources, Assessments, Compliance, Groundwater, Wastewater.

The Maine Department of Environmental Protection, Bureau of Water Quality Control administers the Safe Drinking Water Act Underground Injection Control (UIC) Program. The focus of Maine's program is on Class IV and Class V injection wells. In 1988 and 1989, a questionnaire requesting information on discharges was sent to service stations. The survey responses, in association with field inspections and categorization of floor drain discharges served as the basis for the development of a UIC Class IV and Class V program. The UIC program is one component of the Maine Groundwater Management Strategy, and relies upon interagency coordination with the Wellhead Protection Program and use of existing state computer database systems to provide information on potential Class IV and Class V injection wells. Goals of the UIC Program were accomplished through the use of mail surveys to inventory the nature and extent of UIC activities, the development of a field inspection and enforcement/compliance strategy with an interagency approach, notification of facilities operating Class IV and V wells with a request for voluntary compliance, formal enforcement against selected facilities, and providing fact sheets to potential violators and the general public explaining the UIC program. Automation of the UIC database permitted more efficient management of survey results in order to expedite the mailing of regulations and best management practice notices, and increases the efficiency of compliance and initiation of enforcement activities. The UIC Program also funded the development of a program for municipal officials to provide technical assistance information on how communities can control Class IV and Class V UIC wells. (See also W91-03921) (Author's abstract)
W91-03936

DEEP WASTEWATER RESERVOIRS IN ISRAEL: EMPIRICAL DATA FOR MONITORING AND CONTROL.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
I. Dor, and M. Raber.
Water Research WATRAG, Vol. 24, No. 9, p 1077-1084, September 1990. 12 fig, 2 tab, 12 ref.

Descriptors: *Irrigation water, *Israel, *Light penetration, *Wastewater disposal, *Wastewater irrigation, *Water quality, *Water reuse, Biochemical oxygen demand, Chlorophyll, Dissolved oxygen, Monitoring, Organic loading, Organic matter, Reservoirs, Suspended solids.

Selected physico-chemical and biological variables were investigated in twelve reservoirs storing wastewater for irrigation. Organic load on the various reservoirs ranged from 1 to 15 kg BOD/

1000 cu m/day; BOD of the reservoirs effluent ranged from 1 to 120 mg/L; total suspended solids (TSS) from 6 to 150 mg/L; chlorophyll and rates of respiration from 0.07 to 5 mg/L O2/L/hr. Significant correlation coefficients obtained between the above variables proved that, despite their wide heterogeneity, these reservoirs constitute a well defined category of aquatic ecosystems, where a predictable behavior is induced by increasing concentration of organic matter. The fact that water column transparency appeared significantly correlated with the concentration of BOD, TSS, chlorophyll and dissolved oxygen, indicates that underwater light measurements can serve as a useful parameter for a rapid assessment of reservoir water quality. Under the existing design, operation and local climatic conditions BOD levels of 40-50 mg/L appeared to be the upper limit for the safe performance of these reservoirs. In order to support such concentrations the organic load should not exceed 6 kg BOD/1000 cu m/day. Reservoirs operated within the above limits store wastewater without causing nuisances and reduce the entering BOD by some 80%, which seems to be the maximal efficiency of these systems. (Author's abstract)
W91-04036

RAPID METHANE OXIDATION IN A LANDFILL COVER SOIL.
Alaska Univ., Fairbanks. Inst. of Marine Science.
S. C. Whalen, W. S. Reeburgh, and K. A. Sandbeck.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3405-3411, November 1990. 5 fig, 3 tab, 44 ref. NASA Grant NASW 841, RTOP 197-41-01.

Descriptors: *Biodegradation, *Landfills, *Methane bacteria, *Methanogenesis, *Oxidation, *Soil bacteria, *Waste disposal, Biomass, California, Global warming, Landfill covers, Methane, Microbiological studies, Microorganisms, Soil temperature, Soil water.

Methane oxidation rates observed in a topsoil covering a retired landfill were the highest reported (45 g/square m/day) for any environment. Microbial action was studied in topsoil from the Berkeley North Waterfront Park near San Francisco, California. This 40 hectare park was constructed over a municipal landfill that was retired in 1983. The landfill is presently covered with 1.5 to 3 m of soil in the area of sample collection. The microbial community had the capacity to rapidly oxidize CH4 at concentrations ranging from < 1 microL/L to > 10,000 microL/L. The physiological characteristics of a methanotroph isolated from the soil and the natural population, however, were similar to those of other natural populations and cultures: optimum temperature was 31 C, the apparent half-saturation constant was 2.5 to 9.3 micromoles, and 19-69% of oxidized CH4 was assimilated into biomass. The CH4 oxidation rate of this soil under waterlogged conditions, was near rates reported for lake sediment and much lower than the rate of 116 mg/L/day in the same soil under moist conditions. Since there are no large physiological differences between this microbial community and other CH4 oxidizers, the high CH4 oxidation rate in moist soil is attributed to enhanced CH4 transport to the microorganisms; gas-phase molecular diffusion is 10,000-fold faster than aqueous diffusion. These high CH4 oxidation rates in moist soil have implications that are important in global climate change. Soil CH4 oxidation could become a negative feedback to atmospheric CH4 increases (and warming) in areas that are presently waterlogged but are projected to undergo a reduction in summer soil moisture. (Mertz-PTT)
W91-04065

USE OF NON-CONSERVATIVE PARAMETERS TO TRACE WASTEWATER EFFLUENTS IN WATER BODIES.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
M. Juanico, D. Ronen, and G. Shelef.
Water Research WATRAG, Vol. 24, No. 10, p 1245-1250, October 1990. 5 fig, 2 tab, 5 ref.

Descriptors: *Environmental tracers, *Israel, *Path of pollutants, *Tracers, *Wastewater disposal, *Water quality, Ammonia, Conductivity, Kjeldahl procedure, Mixing, Nitrates, Phosphates, Reservoir operation, Wastewater irrigation, Water quality control.

An alternative method to label wastewater effluent entering water bodies when classic tracers (artificial tracers and conservative parameters of the water masses) cannot be used was examined. The method is based on the simultaneous use of several non-conservative effluent quality parameters (for example, electrical conductivity, detergents, PO4, alkalinity, Na, Kjeldahl, NH4, and NO2), which smooths out of the high variability of single non-conservative parameters, disclosing their common trend. The obtained estimates, although not quantitative, can be expressed in an ordinal scale. The performance of the new multi-tracer method was tested in a case study to estimate the relative amount of effluent in the outflow of an operational reservoir which receives freshwater and sporadic inputs of treated wastewater. The Kishon Complex is a wastewater reclamation system for irrigation in Israel. Municipal sewage from Haifa is treated and pumped through a 28 km long pipe line as the only inflow to a stabilization reservoir with two cells. The stabilization reservoir is 10 m deep and has a storage capacity of 12 million cubic meters. The multi-tracer method disclosed poor mixing conditions between freshwater and effluents within the reservoir, plug flow-like movement of the effluent pulses with a delay of 1-3 weeks between an inpulse and its corresponding out-pulse, and the existence of dead spaces in the reservoir. (Mertz-PTT)
W91-04079

ABSORPTION OF WATER INTO POROUS BLOCKS OF VARIOUS SHAPES AND SIZES.
California Univ., Berkeley. Earth Sciences Div.
R. W. Zimmerman, and G. S. Bodvarsson.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2797-2806, November 1990. 9 fig, 29 ref. DOE Contract DE-AC03-76SF00098.

Descriptors: *Geohydrology, *Groundwater movement, *Nevada, *Path of pollutants, *Porosity, *Radioactive wastes, *Waste disposal, Mathematical analysis, Mathematical models, Permeability, Rock properties, Scaling law, Site selection, Yucca Mountain.

Yucca Mountain in Nevada is currently being considered for the location of an underground repository for the disposal of high-level radioactive waste. The proposed repository would be constructed in the unsaturated zone above the water table, in a formation consisting of extensively fractured volcanic tuff. As part of the process of characterizing the site for the purposes of determining its suitability for the repository, it is necessary to develop models for studying the flow of groundwater in a fractured rock mass with low matrix permeability. Approximate solutions for absorption of water into porous spherical, cylindrical, and slablike blocks whose characteristics curves are of the van Genuchten-Mualem type were calculated. The solutions were compared to numerical simulations of absorption into blocks of the Topopah Spring member (Paintbrush tuff) from the site of the proposed nuclear waste repository at Yucca Mountain. Guided by these results, a scaling law, based on the ratio of surface area to volume was proposed for prediction the rate of absorption into irregularly shaped blocks. This scaling law was tested against a numerical simulation of absorption into an irregularly shaped, 2-dimensional polygonal block and was shown to be a good approximation. (Mertz-PTT)
W91-04133

IMPORTANCE OF AIR ABSORPTION DURING MECHANICAL INTEGRITY TESTING.
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
For primary bibliographic entry see Field 5G.
W91-04135

DIFFUSION IN THE MATRIX OF GRANITIC ROCK: FIELD TEST IN THE STRIP A MINE.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
L. Birgersson, and I. Neretnieks.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2833-2842, November 1990. 23 fig, 4 tab, 20 ref.

Descriptors: *Crystalline rocks, *Groundwater movement, *Hazardous waste disposal, *Path of pollutants, *Radioactive wastes, *Underground waste disposal, Diffusivity, Fracture permeability, Hydraulic conductivity, Porosity, Rock mechanics, Tracers.

In laboratory measurements, the matrix of crystalline rocks has been found to have a connected porosity. In the case of radionuclides leaking from a final repository for nuclear waste, the potential uptake into the rock matrix may be one of the most important retardation mechanisms for nuclides transported by mobile water in the fractures. Three field experiments in granitic rock were performed at 360 m depth in a mine to investigate diffusion in the undisturbed rock matrix. The most convincing way of doing this type of experiment is to perform a tracer experiment with diffusion as the only transport process. This was, however, not practical because of the existing pressure gradient in the rock. Thus, the actual experiments involved both advection and diffusion. The results from all three experiments showed that tracers had migrated through the disturbed zone close to the injection hole and a distance into the undisturbed rock matrix. These results showed that it was possible for dissolved compounds to migrate into the rock matrix in its natural stress environment. Diffusivities and hydraulic conductivities obtained in this in situ experiment compare well with those obtained in laboratory experiments. (Mertz-PTT)
W91-04137

BIOSORPTION OF RADIONUCLIDES BY FUNGAL BIOMASS.
Dundee Univ. (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5D.
W91-04156

REVIEW OF BIOTECHNOLOGY APPLICATIONS TO NUCLEAR WASTE TREATMENT.
PA Consulting Group--Technology, Cambridge Laboratory, Melbourn, Royston, Hertfordshire SG8 6DP, England.
N. V. Ashley, and D. J. W. Roach.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 49, No. 4, p 381-394, 1990. 2 fig, 3 tab, 26 ref.

Descriptors: *Biological treatment, *Biotechnology, *Literature review, *Radioactive wastes, *Waste treatment, Biopolymers, Biosorption.

An overview of the feasibility of the application of biotechnology to nuclear waste treatment is reviewed. The main areas of biotechnology that will have an impact on aqueous nuclear effluent treatment are biopolymers and biosorbents. Biopolymers were judged to offer few short-term applications benefits except perhaps for lignin, chitin and modified cellulosics. The long-term potential for biopolymers was projected to be in the area of genetic and protein engineering for biopolymers such as metallothioneins and siderophores. Biosorption offers a potentially efficient method of removal of radionuclides from aqueous nuclear waste streams. Selected fungi, yeast, bacteria and algae can all function as effective biosorbents and can function in immobilized systems. New and potential applications of biotechnology for nuclear waste treatment include biomagnetic separation, immobilized antibodies, and genetic engineering. (MacKeen-PTT)
W91-04159

POTENTIAL SIGNIFICANCE OF MICROBIAL ACTIVITY IN RADIOACTIVE WASTE DISPOSAL.
Nuclear Electric, Barnwood (England).
A. McCabe.

Experientia EXPEAM, Vol. 46, No. 8, p 779-787, August 15, 1990. 4 tab, 90 ref.

Descriptors: *Backfill, *Hydrogen ion concentration, *Microbiological studies, *Microorganisms, *Path of pollutants, *Radioactive waste disposal, *Reviews, *Waste containment, Aerobic conditions, Anaerobic conditions, Nutrient requirements, Organic carbon, Performance evaluation.

The design of radioactive waste depositories is reviewed with respect to the effects of microbial activity on radioactive waste containment. Microbes may affect the repository either by attack from outside or from within the waste. External microorganisms could possibly degrade the backfill and canister materials but pH and nutritional requirements militate against such action. When cement is used extensively, the ability of microorganisms to degrade containment materials is curtailed by the high pH imposed, whcih will effectively restrict microbial activity. In some waste forms, however, microenvironments wherein a localized acidic regime may become established should not be neglected. Restriction of nutrient sources in the near-field, particularly of carbon, acts as a powerful constraint on microbial activity. Microbial activity is stimulated by the addition of extra organic carbon and thus biomass will increase. Carbon dioxide produced could support autotrophs. Other necessary nutrients, e.g., phosphorus, nitrogen and sulfur, are also available in sufficient amounts. A number of factors are important to evaluate microbial activity within the waste form itself and its consequences. Water as a prerequisite for microbial activity will not be adequately present through a cement monolith. However, local redistribution of water within the waste form, evaporation/condensation could cause local areas of moisture. The nature of the backfill will have profound microbiological consequences. Calcium montmorillonite (Fuller's Earth) and water samples contain microorganisms of important microbial groups, e.g., aerobic heterotrophs, iron-precipitating heterotrophs, denitrifiers, sulfur oxidizers, and sulfate-reducing bacteria. The use of such clay materials to backfill and seal deep repositories will introduce nutrients, however, compacted clay will restrict water movement and any additional nutrient input. Oxygen availability, entering e.g. the groundwater, will be an important determinant for microbial life since the waste will probably contain both aerobic and anaerobic organisms. However, microbial activity occurring within the waste form requires further evaluation. (Korn-PTT)
W91-04260

DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL WASTE IN SWITZERLAND: BASIC ASPECTS OF POTENTIAL RELEVANCE TO MICROBIAL EFFECTS.

Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle, Baden (Switzerland).
B. Knecht, I. G. McKinley, and P. Zuidema.
Experientia EXPEAM, Vol. 46, No. 8, p 787-791, August 15, 1990. 2 fig, 3 ref.

Descriptors: *Backfill, *Hydrogen ion concentration, *Microbial transport, *Microbiological studies, *Path of pollutants, *Radioactive waste disposal, *Switzerland, Cements, Marl, Microorganisms, Organic carbon, Performance evaluation, Radioactive wastes, Resins.

Current projects for the disposal of low-level and intermediate-level radioactive waste in Switzerland are based on the concept of a horizontally accessed repository under a hillslope. The waste is generally solidified in cement and placed in steel drums or concrete containers. Once the repository caverns have become filled with waste, they will be backfilled with a porous mortar to allow gases, produced by the anaerobic corrosion of steel and by microbial degradation of organic material, to escape from the near field. Valanginian marl is one of three envisaged options for the host rock. The groundwater, in the vicinity of the repository, is reducing, and its pH is in the neutral to slightly alkaline range. The engineered barriers will thus present a hyperalkaline, oligiotrophic environment which, even if not sufficient to ensure sterility, will considerably constrain microbial activity. Potentially important microbial effects on the long-term performance of the system are the effect of microorganisms on radionuclide sorption and the role of microorganisms as global geochemical catalysts. In terms of radionuclide release and transport, the key factors include the extent of uptake by microorganisms, the interaction of such microorganisms with rocks, the degradation of organic materials in the waste and in the rock (potentially leading to increased concentrations of complexing agents), and the effects of the microorganisms and their by-products on radionuclide sorption. Finally, the role of microbes as catalysts should not be ignored--particularly their catalysis of slow redox geochemical reactions (i.e., S, N, C) in the groundwater system. The catalysts can indirectly affect both barrier performance and radionuclide speciation/solubility. (Korn-PTT)
W91-04261

SWEDISH FINAL REPOSITORY AND THE POSSIBLE RISK OF INTERACTIONS BY MICROBIAL ACTIVITIES.

Foersvarets Forskningsanstalt, Umea (Sweden).
R. Roffey.
Experientia EXPEAM, Vol. 46, No. 8, p 792-794, August 15, 1990. 1 fig, 3 tab, 18 ref.

Descriptors: *Backfill, *Microbial transport, *Microbiological studies, *Microorganisms, *Path of pollutants, *Radioactive waste disposal, *Sweden, Aerobic conditions, Anaerobic conditions, Hydrogen ion concentration, Performance evaluation, Radioactive wastes, Resins.

Low-level and intermediate-level radioactive waste in Sweden will be stored in a repository consisting of a number of mined rock caverns situated off the coast of Uppland around 50 m below the Baltic sea bed. The repository will be surrounded by a concrete barrier, and outside this there will be a clay (bentonite) barrier to minimize water flow through the system. Recently, it has been determined that microbial activity could exist in the vicinity of nuclear waste repository. The composition of the waste, as well as the environmental conditions, will determine the extent of microbial activity. One important factor is the amount of biodegradable materials, such as cellulose, organic compounds in ion exchangers, and textile materials, in the repository. In addition, some of the waste will be encapsulated in bitumen which is expected to be aerobically degraded by microbes present in the repository. An analysis of ground water surrounding the storage site shows the presence of a small number of microorganisms including hydrocarbon degrading bacteria. The stability of bitumen may be reduced in an environment capable of sustaining microbial life. Colonization of bitumenized waste by microbes, and products from degradative processes, could accelerate radionuclide release. In addition, microbial activity may also contribute directly or indirectly to corrosion of other barrier materials and give rise to gas (e.g., CO2) evolution with the risk of increased internal pressure developing in the repository. The production of carbon dioxide due to aerobic and anaerobic processes might lead to a decrease in the pH of the groundwater, inducing corrosion of the metal construction and storage containers, with large amounts of hydrogen gas being produced. (Korn-PTT)
W91-04262

MICROBIAL ACTIVITY IN THE TERRESTRIAL SUBSURFACE.

Pennsylvania State Univ., University Park. Lab. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-04263

MICROBIAL DISSOLUTION AND STABILIZATION OF TOXIC METALS AND RADIONUCLIDES IN MIXED WASTES.

Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
A. J. Francis.
Experientia EXPEAM, Vol. 46, No. 8, p 840-851, August 15, 1990. 3 fig, 2 tab, 128 ref. DOE Contract No. De-AC02-76CH00016.

Descriptors: *Coal wastes, *Groundwater pollution, *Microbiological studies, *Organic compounds, *Path of pollutants, *Plutonium, *Radioactive waste disposal, *Reviews, *Toxic wastes, *Uranium, *Waste treatment, *Wastewater treatment, Aerobic conditions, Anaerobic conditions, Carbonates, Fate of pollutants, Metals.

Microorganisms, which are ubiquitous throughout nature, have long been recognized for their ability to bring about transformations of organic and inorganic compounds. Such microbial processes have not been fully exploited in the treatment and management of nuclear and fossil-energy wastes, particularly in regulating the mobility of toxic metals and radionuclides or in the biodegradation of organic constituents to innocuous products. These microbial processes can occur under aerobic, denitrifying, iron-reducing, fermentative, sulfate-reducing, and methanogenic conditions. The organic compounds and inorganic elements (major and minor metals and radionuclides), depending upon their chemical forms, may react with each other to varying degrees in the waste. These reactions include organic-inorganic complex formation, precipitation reactions, coprecipitation of metals and radionuclides with Fe and Mn oxides, and the formation of minerals. Microbial activity in mixed wastes can have an appreciable effect on the dissolution or precipitation of toxic metals and radionuclides. However, fundamental information on microbial dissolution and stabilization (immobilization) of toxic metals and radionuclides (i.e., actinides and fission products) continues to be very limited, as was discovered in this review of relevant literature. However, the acquisition of such information will be useful in the development of (1) predictive models on the fate and long-term transport of toxic metals and radionuclides from waste disposal sites, and (2) biotechnological applications of waste treatment leading to volume reduction and stabilization of radionuclides and toxic metals. (Korn-PTT)
W91-04264

FACTORS INFLUENCING THE CHEMICAL CHARACTERISTICS OF LANDFILL LEACHATES.

Ross Consultancy, Tygerpark (South Africa).
For primary bibliographic entry see Field 5B.
W91-04319

LISTERIA MONOCYTOGENES CONTAMINATION OF CROPS GROWN ON SOIL TREATED WITH SEWAGE SLUDGE CAKE.

Biological Research Center, Baghdad (Iraq).
For primary bibliographic entry see Field 5B.
W91-04367

RECREATIONAL WATER QUALITY: THE MANAGEMENT OF ENVIRONMENTAL HEALTH RISKS ASSOCIATED WITH SEWAGE DISCHARGES.

A. Godfree, F. Jones, and D. Kay.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 9, p 414-422, September 1990. 1 fig, 3 tab, 71 ref.

Descriptors: *Estimated costs, *Human pathogens, *Path of pollutants, *Recreation facilities, *Resource management, *Risk assessment, *Sewers, *Wastewater pollution, *Water pollution control, *Water quality standards, Bacterial analysis, Economic impact, Fecal coliforms, Flow rates, Health risk, Reservoirs, Viruses.

Marine environments are a source of water recreation including bathing, and they act as receiving waters and reservoirs. Epidemiological studies are required to assess any health risk in using polluted bathing waters and in order to establish the degree of public health risk in using sewage polluted water, and the relationship and correlation with microbial standards and indicator bacteria or viruses. The implementation of the EC Directive 76/160/EEC has provided numerical values for nineteen water quality parameters, principally microbiological parameters. Compliance assessment in the UK is performed using total and fecal coliforms, despite the inclusion of salmonella and vi-

ruses in the Directive. The designers of marine outfalls began to incorporate the mandatory coliform levels for coastal waters into their design parameters. The use of predictive modelling provided a mechanism for evaluating potential outfall configurations with a principal objective being compliance with the fecal coliforms criteria of 2000/100 ml. In the absence of other criteria, designers continue with the EC Directive Standards as a basis for performance. The costs of constructing environmentally acceptable discharge systems to the marine environment are considerable, for example the costs of construction of a 5 km outfall, serving a resident population of 250,000, taking into account sewage works and a facility for storage of proportion of storm flows has been estimated at 55.2 million pounds. Quality controlled microbial analysis must be established so that data may be readily compared and used to survey and control sewage discharges and traditional and novel means of treatment. (Brunone-PTT)
W91-04513

ECONOMIC EFFECTS OF LONG-TERM RESTRICTIONS ON DRAINAGE WATER DISPOSAL.
Rhode Island Univ., Kingston. Dept. of Resource Economics.
For primary bibliographic entry see Field 5G.
W91-04535

DEWATERING PROBLEMS LEAD TO LIQUID SLUDGE DISPOSAL.
Broward County Office of Environmental Services, Pompano Beach, FL. Wastewater Management Div.
For primary bibliographic entry see Field 5D.
W91-04595

LOS ANGELES CITY SLUDGE MANAGEMENT PROGRAM.
Los Angeles City Hyperion Treatment Plant, Playa Del Rey, CA.
J. T. Crosse, and S. C. Molyneux.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 15,17, November 1990.

Descriptors: *California, *Los Angeles, *Sludge disposal, *Sludge utilization, *Waste disposal, *Waste treatment, Chemical treatment, Composting, Hyperion energy recovery system, Land disposal, Ocean dumping, Regulations.

Sludge management has become a major challenge facing publicly owned treatment works across the U.S. The city of Los Angeles, California, operates four wastewater treatment plants, treats 460 mgd of wastewater, and produces over 1400 wet tons per day of dewatered digested wastewater sludge at 20% solids concentration. Los Angeles had begun efforts to eliminate ocean sludge dumping in 1972, and turned to a Hyperion Energy Recovery System (HER). This system provided on-site sludge handling for up to 1300 ton/day of sludge cake by drying and then combusting the sludge for power generation. However, problems developed and the city began hauling sludge to landfills. In 1987 the city shifted focus and developed a plan for solids handling through the year 2010. In pursuit of these goals, the city solicited innovative and alternative proposals from the private sector. Flexible programs that were developed to respond to a plant's fluctuating operational conditions included: (1) hyperion energy recovery systems; (2) chemical treatment; (3) land application; and (4) composting. All projects using city wastewater sludge must meet the guidelines of the California Environmental Quality Act to ensure compliance with all applicable federal, state, and local regulations. Since November 1987, ocean disposal has been replaced by landfilling and a newly constructed on-site recovery facility. In the past two years, the city has developed three additional alternatives for beneficially reusing over 1400 wet tons per day of sludge, and is aggressively managing a quality sludge management program. (White-Reimer-PTT)
W91-04596

EPA'S TECHNICAL SLUDGE REGULATIONS MAY END BENEFICIAL REUSE.
Tennessee Dept. of Health and Environment, Nashville.
For primary bibliographic entry see Field 5G.
W91-04599

PRELIMINARY SITE EVALUATION FOR AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE A GUIDE FOR WWTP TECHNICIANS.
Gannett, Fleming, Corddry and Carpenter, Inc., Harrisburg, PA.
T. Johnston.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 6, p 9-11, November/December 1990. 1 fig.

Descriptors: *Cropland, *Farming, *Pennsylvania, *Sludge disposal, *Sludge utilization, Crops, Land disposal, Manure, Permit requirements, Regulations.

As a result of the recently adopted Pennsylvania Department of Environmental Resources (DER) Municipal Waste Regulations, the selection of adequate sites for agricultural utilization of sewage sludge has become increasingly difficult. Therefore a step-by-step procedure for wastewater treatment plant (WWTP) personnel for screening agricultural utilization sites has been outlined. The first step is to contact potentially receptive farmers. Sludge can be promoted as a valuable product; a soil nutrient and conditioner provided at no cost. Second, one must prepare for a site visit and obtain a Soil Survey for the county where the farm is located. Soil Surveys are detailed soils manuals developed by the U.S. Department of Agriculture and Soil Conservation Service in Cooperation with the Pennsylvania State University and DER. An application must be completed that includes a manure management plan that is used to determine the quantity of manure generated on the farm in order to calculate the nutrient value of the manure produced. At the initial site visit one must review various aspects of the permit requirements with the farmer and collect the necessary information for the permit. It is then necessary to 'walk' the farm and examine each field individually for slope, sinkholes or rock outcrops, soil drainage, soil type, current crops, and presence of streams. The decision to utilize the farm for sludge disposal should consider: whether or not there is sufficient acceptable acreage for the permitting process; is there sufficient acreage for both manure produced on the farm and the areas for permitting; and will the farmer withdraw from the program if the neighbors object to sludge application. (White-Reimer-PTT)
W91-04606

GROUND-WATER QUALITY NEAR A SCAVENGER-WASTE-DISPOSAL FACILITY IN MANORVILLE, SUFFOLK COUNTY, NEW YORK, 1984-85.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04647

COMPOST MARKETING IN NEW ENGLAND.
Dufresne-Henry, Inc., North Springfield, VT.
M. E. Lang, and R. A. Jager.
Biocycle BCYCDK, Vol. 31, No. 11, p 68-71, November 1990. 2 tab, 2 ref.

Descriptors: *Compost, *Marketing, Composting, New England, Public lands, Public policy, Sludge, Sludge disposal, Sludge utilization.

Sludge composting has become a widely accepted sludge management technology throughout New England. There are 35 facilities currently operating in the six state region, processing approximately 150 dry tons of sludge per day. Interest in composting continues, as demonstrated by 16 facilities in design or construction phases. Another 17 municipalities and six regional authorities are considering implementing composting programs. A survey of the 35 composting facilities currently operating in New England was conducted to determine the success of their compost marketing programs. Nineteen facilities provide compost for public agencies to use. Typical recurring uses include the maintenance of parks, recreational areas, cemeteries, road embankments and building grounds. Large, one-time uses of compost include the construction of baseball fields, cemeteries, and the installation of roadside curbing. General and landscape contractors also represent a major market for compost in New England. Homeowners represent a significant market at several of the facilities, but the agricultural market is underdeveloped. Private brokers understand the benefits of using compost and are often associated with large volume soil users. Five facilities report the use of their compost in the production of loam. Two facilities report the use of their compost to reclaim exhausted gravel pits and a third reported using compost in reclaiming a sandpit. The survey identified four key factors in existing, successful marketing programs. Successful marketers understand the proper use of compost and convey this information to end product users. They maintain communication with users to help overcome any difficulties, and share in their successes. They also encourage public agencies and contractors performing public work to use compost, allowing development of visible examples of its benefits. (Mertz-PTT)
W91-04760

ANALYTICAL AND SPECTROSCOPIC CHARACTERIZATION OF HUMIC ACIDS EXTRACTED FROM SEWAGE SLUDGE, MANURE, AND WORM COMPOST.
Sassari Univ. (Italy). Inst. di Chimica Agraria.
S. Deiana, C. Gessa, B. Manunza, R. Rausa, and R. Seeber.
Soil Science SOSCAK, Vol. 150, No. 1, p 419-424, 1990. 4 fig, 5 tab, 17 ref.

Descriptors: *Compost, *Humic acids, *Land disposal, *Manure, *Sludge, *Sludge analysis, *Soil analysis, *Spectroscopy, *Wastewater, Carbon content, Fertilization, Polysaccharides, Proteins, Soil chemistry.

Humic acids extracted from sewage sludge, manure, and worm compost have been characterized by chemical and spectroscopic methods. Meaningful differences in the composition were revealed by Fourier transformation infrared, proton, carbon-13 NMR, and visible spectroscopies. These differences allow a differentiation among the products depending on the source from which they were obtained. Humic acid extracted from sewage sludge contains the highest percentage of aliphatic carbon, associated with polysaccharides and proteinaceous structures, and has characteristics close to those of aquatic humic acids. On the other hand, humic acids from manure and worm compost are similar to the humic acids originating from soil. (Author's abstract)
W91-04797

COMMON-SENSE LIQUID SLUDGE MANAGEMENT.
Envirotech Operating Services, Dayton, OH.
L. S. Royer, and N. Brookhart.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 52-57, December 1990. 3 fig.

Descriptors: *Liquid sludge, *Sludge disposal, *Sludge utilization, *Soil amendments, Cropland, Injection, Marketing, Municipal wastewater, Ohio, Storage requirements, Subsurface sludge injection, Waste storage.

Land application of liquid municipal sludge has long been a popular choice for sludge disposal, primarily because of low capital and operating costs. The volume of liquid sludge, particularly at medium and large facilities can be a significant obstacle. Cost of transporting sludge also increases sludge disposal operation costs. The Miami Conservancy District is a regional public agency whose primary responsibility is flood prevention and control on the Great Miami River in southwestern Ohio. Major accomplishments of the conservancy district have been the construction of

two wastewater treatment plants. One of the basic goals of the engineers in designing the sludge disposal project for the plants was to demonstrate that direct injection of sludge on agricultural land could benefit and be coordinated with a successful agricultural operation. In planning a sludge management program, many factors including public relations, facility size, and personnel and energy requirements, and previous experiences must be considered. To be compatible with agricultural operations, sludge must be stored during the growing season when crops are in the ground. Storage should be provided at the disposal sites rather than at the plant so that transportation of sludge to the sites could take place during the crop season and winter months. Subsurface sludge injection was the application method of choice. Direct injection allowed for immediate incorporation of the sludge into the soil. Monitoring wells were set up on the site and computer software was developed to coordinate data on sludge application, and groundwater monitoring. The Miami Conservancy District has found that their sludge land application program is both manageable and cost effective. (Mertz-PTT)
W91-04819

GRAVITY BELT THICKENING AND LIME STABILIZATION.
EIMCO Process Equipment Co., Salt Lake City, UT.
D. F. Ritter.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 58-63, December 1990. 2 fig, 3 tab.

Descriptors: *Land disposal, *Sludge thickening, *Sludge treatment, *Soil amendments, *Wastewater facilities, *Wastewater treatment, Advanced wastewater treatment, Ammonia removal, Cropland, Gravity, Gravity belt thickening, Lime, Lime stabilization, Sludge, Sludge utilization, Storage.

In a recent plant expansion from 3.7 to 8.5 million gallons/day that included an upgrade to ammonia nitrogen removal, the advanced wastewater treatment plant in Oaks, Pennsylvania selected a gravity belt thickening and lime stabilization system for the daily treatment of 5900 kg of sludge. This system was selected because of the consistent performance and easy operation of the gravity belt thickeners and because of the relatively lower capital and operational costs associated with the gravity belt thickening and lime stabilization system, compared to other processes considered. The system consists of several components. Primary and waste activated sludge from both aeration processes are pumped to the holding tank for blending thickening. The sludge is blended by a submersible mechanical mixer in the holding tank and then pumped by the progressive cavity thickener feed pumps to the gravity belt thickeners. Lime slurry is added to the sludge as it is discharged from the gravity belt thickeners through a chute into the open-throat progressive cavity thickened-sludge pumps. The sludge is then pumped to the sludge storage tank where the lime is further mixed with the sludge by two submersible mechanical mixers in the storage tank. From the sludge storage tank, the thickened, lime-stabilized sludge is pumped by the progressive cavity sludge transfer pump through a liquid-loading arm to a tanker truck for application on nearby farmland. (Mertz-PTT)
W91-04820

LESSONS LEARNED FROM COMPACTED CLAY LINER.
McClelland Engineers, Inc., Houston, TX.
For primary bibliographic entry see Field 5G.
W91-04839

RECONNAISSANCE STUDY OF THE THICKNESS OF THE UNSATURATED ZONE IN THE WESTERN CONTERMINOUS UNITED STATES.
Geological Survey, Lakewood, CO. Water Resources Div.
M. S. Bedinger, and W. H. Langer.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Atlas HA-715, 1989. 1p, 7 fig, 1 map, 13 ref.

Descriptors: *Aeration zone, *Hazardous waste disposal, *Hydrologic budget, *Hydrologic maps, *Radioactive waste disposal, *Site selection, *Surveys, *Unsaturated zone, Arizona, California, Colorado, Groundwater movement, Groundwater recharge, Groundwater resources, Idaho, Montana, Nevada, Oregon, Precipitation, Surface-groundwater relations, Texas, Utah, Washington, Wyoming.

In 1984, the US Geological Survey began a study of the geohydrologic characteristics of the unsaturated zone in the western United States, extending from the eastern edge of the Rocky Mountains westward and including all or parts of the 12 westernmost State. The goal is to characterize unsaturated flow systems to aid in identifying environments in the western United States that may merit further study for isolation of hazardous waste, including high-level and low-level radioactive waste and other toxic waste. The major physiographic areas discussed in this report are: (1) Rocky Mountain System consisting of the Southern, Middle, and Northern Rocky Mountains, and the Wyoming basin; (2) Intermontane Plateaus consisting of the Basin Range province, and the Colorado and Columbia Plateaus; and (3) Pacific Mountain System. The Colorado and Columbia plateaus, exhibit a variety of geohydrologic conditions. Outstanding features peculiar to the mountainous area of the Rocky Mountain and the Pacific Mountain Systems are the high rugged mountains and steep relief. These mountains receive greater precipitation than do the lower parts of the otherwise dry western United States. Generally, moisture-laden air masses move eastward, and the mountains force them to higher, cooler altitudes. As the air cools, moisture condenses and precipitates. As a result, the Rocky Mountain and Pacific Mountain Systems have annual precipitation in excess of 30 in. The Wyoming Basin, Basin and Range province, Colorado Plateaus, and Columbia Plateaus generally have lower altitudes and less relief than do the mountainous areas. The climate throughout most of these provinces generally is semiarid to arid. Annual precipitation is generally < 16 in. throughout most of the area, and is < 4 in. in some parts. The mean annual surface evaporation ranges from 20 to 100 in. A large part of the study area is subject to a water deficit because potential evapotranspiration exceeds precipitation; as a consequence, groundwater recharge generally is small, surface runoff is small, perennial streams and lakes are few, and the depth to groundwater commonly is large. (Lantz-PTT)
W91-04855

5F. Water Treatment and Quality Alteration

WATER-USE EFFICIENCY STANDARDS FOR PLUMBING FIXTURES: BENEFITS OF NATIONAL LEGISLATION.
Brown and Caldwell, Boston, MA.
For primary bibliographic entry see Field 3D.
W91-03972

OPERATING THE SEATTLE WATER SYSTEM DURING THE 1987 DROUGHT.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3D.
W91-03974

EVALUATING ION EXCHANGE FOR REMOVING RADIUM FROM GROUNDWATER.
Dow Chemical U.S.A., Midland, MI.
S. Subramonian, D. Clifford, and W. Vijjeswarapu.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 61-70, May 1990. 12 fig, 6 tab, 29 ref. Cooperative research agreement CR-813148 between the University of Houston and the EPA.

Descriptors: *Groundwater, *Ion exchange, *Radium, *Radium radioisotopes, *Water treatment, Cation exchange, Performance evaluation, Pilot plants, Regeneration, Resins.

Bench and pilot-scale studies of ion exchange processes for radium removal were conducted using ground water from Lemont, IL, public supply. Batch and column studies indicated a very high resin selectivity for radium compared with common cations. Exhaustion-regeneration studies with a variety of resins showed that a standard gel-type strong-acid cation exchanger is most suitable for radium removal in cycle operation. Because the ion exchange softening process, operated to hardness breakthrough (300-360 bed volumes, BV), removes radium but does not fully utilize the resin capacity, cyclic runs were made with resins exhausted to radium breakthrough (2,500-3,000 BV) and regenerated with sodium and calcium salts. But because the poor regenerability of exhausted resins, simultaneous breakthrough of radium and hardness occurred during the subsequent exhaustion run on the sodium cycle, and high radium leakage was observed on the calcium cycle. A study of factors affecting elution showed that during normal regeneration with 15-20 lb NaCl/cu ft, only 20-25 percent of the adsorbed radium was removed. For the Lemont water containing 12 pCi/L of Ra-226, this left a typical Ra-226 residual of 14,000 pCi Ra-226/L resin after regeneration. Use of very high regenerant dosages (up to 20 times stoichiometric) could desorb 75-90 percent of the adsorbed radium, but such excessive regenerant use, compared with normal dosages of two or three times stoichiometric, would not be economical without incorporation of regenerant-reuse techniques. The sodium ion exchange softening process (operated to hardness breakthrough without regenerant reuse) continues to be an appropriate technology for the removal of radium. (Author's abstract)
W91-03975

MEASURING ALUMINUM DURING WATER TREATMENT: METHODOLOGY AND APPLICATION.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
J. E. Van Benschoten, and J. K. Edzwald.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 71-78, May 1990. 10 fig, 4 tab, 33 ref. EPA Cooperative Agreement CR-812639.

Descriptors: *Aluminum, *Analytical techniques, *Chemical analysis, *Water analysis, *Water treatment, Cation exchange, Chemical speciation, Filtration, Hydrogen ion concentration, Solubility, Temperature effects.

A method for determining aluminum during water treatment is described. The procedure, which involves filtration and cation exchange to isolate specific aluminum fractions followed by analysis, was applied to two municipal water treatment plants. Results showed that 70-80 percent of the aluminum present in treated water was in dissolved form. Residual aluminum concentrations and the extent of oversaturation were affected by the pH of coagulation, the treated water pH, and temperature. Plant operators should vary pH in response to seasonal temperature fluctuations to minimize residual aluminum. (Author's abstract)
W91-03976

EVALUATING OXIDANTS FOR THE REMOVAL OF MODEL TASTE AND ODOR COMPOUNDS FROM A MUNICIPAL WATER SUPPLY.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
W. H. Glaze, R. Schep, W. Chauncey, E. C. Ruth, and J. J. Zarnoch.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 79-84, May 1990. 5 tab, 37 ref.

Descriptors: *Chemical treatment, *Odor control, *Organoleptic properties, *Oxidation process,

*Water treatment, California, Hydrogen peroxide, Odors, Ozonation, Ozone, Taste.

Nine oxidizing agents were evaluated for removing six taste and odor compounds spiked into Colorado River water (CRW), one of the supplies of the Metropolitan Water District (MWD) of Southern California. Of the oxidation processes investigated, ozone alone and ozone with hydrogen peroxide appear to have the most potential for control of taste and odor compounds at existing MWD plants. In State Project water (SPW), another MWD source water, the rate of oxidation of geosmin and methylisoborneol (MIB) with ozone--with or without hydrogen peroxide--is higher than in CRW. The oxidation of geosmin and MIB is postulated to occur through the formation of highly reactive hydroxyl radicals. The higher oxidation rates in SPW are indicative of higher levels of natural inhibitors of ozone decomposition and lower levels of hydroxyl radical scavengers. (Author's abstract)
W91-03977

OPTIMAL UPGRADING OF HYDRAULIC-NETWORK RELIABILITY.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W91-03992

OZONATION OF PYRENE IN AQUEOUS SOLUTION.
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
C. E. Corless, G. L. Reynolds, N. J. D. Graham, and R. Perry.
Water Research WATRAG, Vol. 24, No. 9, p 1119-1123, September 1990. 5 fig, 18 ref.

Descriptors: *Aromatic compounds, *Disinfection, *Ozonation, *Polycyclic aromatic hydrocarbons, *Water treatment, Gas chromatography, High performance liquid chromatography, Mass spectrophotometry, Oxidation, Pollutant identification, Potable water.

The reaction of pyrene with ozone was studied in aqueous solution at low (10-200 micrograms/L) substrate concentration and with ozone concentrations (5 mg/L) approximating those used in potable water treatment. Degree of reaction and the formation of polyaromatic/aromatic reaction products were assessed using a technique of solvent extraction and derivatization with gas chromatographic (GC), gas chromatographic-mass spectrometric (GC-MS), high performance liquid chromatographic (HPLC) and ultraviolet spectrometric analysis of extracts. A freeze drying/derivatization technique with GC and GC-MS analysis was employed for the isolation/identification of short chain polar aliphatic reaction products. Substantial destruction of pyrene was recorded within 1 min of reaction with ozone. Polyaromatic/aromatic compounds did not persist; reaction products are likely to be short chain polar aliphatic compounds. Products of this type were isolated but not identified in the study. (Author's abstract)
W91-04041

DIFFERENT SURFACE GEOLOGY IN DENMARK, THE FAROE ISLANDS AND GREENLAND INFLUENCES THE RADIOLOGICAL CONTAMINATION OF DRINKING WATER.
Risoe National Lab., Roskilde (Denmark). Health Physics Dept.
For primary bibliographic entry see Field 5B.
W91-04044

RESIN CONCENTRATION OF BY-PRODUCTS FROM CHLORINATION OF AQUATIC HUMIC SUBSTANCES.
Ecole Nationale Superieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Genie de l'Environnement.
P. LeCloirec, R. M. Lelacheur, J. D. Johnson, and R. F. Christman.
Water Research WATRAG, Vol. 24, No. 9, p 1151-1155, September 1990. 2 fig, 4 tab, 24 ref. NSF Grant CEE83-12997.

Descriptors: *Chlorination, *Halogenated compounds, *Humic substances, *Pollutant identification, *Water treatment, Adsorption, Organic carbon, Separation techniques.

A method to extract and concentrate the by-products from chlorination of an isolated aquatic humic substance was investigated. Particular attention was given to maximization of the recovery of compounds characterized as total organic halogens. After evaluation of different XAD resins with model compounds, the method chosen involved sequential adsorption of an acidified aqueous sample onto XAD-8 and XAD-4 resins, and product recovery first with base elution and then soxhlet ether extraction of the resins. This method yielded a recovery of 72% of total organic carbon and 97% of total organic halogens. (Author's abstract)
W91-04046

INFLUENCE OF PHOSPHORUS ON GROWTH AND NUTRIENT STORAGE BY WATER HYACINTH (EICHHORNIA CRASSIPES (MART.) SOLMS) PLANTS.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5D.
W91-04052

ADSORPTION ISOTHERMS: ILLUSIVE CAPACITY AND ROLE OF OXYGEN.
Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W91-04072

BROMATE PRODUCTION IN CHLORINATED WATERS: REACTION OF MONOCHLORAMINE AND HYPOBROMITE.
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W91-04085

WATER DISTRIBUTION IN EL PASO--MODELING A COMPLEX SYSTEM.
Camp, Dresser and McKee, Inc., Dallas, TX.
D. Mueller, and H. Juarez.
Public Works PUWOAH, Vol. 121, No. 12, p 44-45, November 1990.

Descriptors: *Computer models, *Model studies, *Municipal water, *Texas, *Water distribution, *Water resources management, Databases, Graphical analysis, Management planning, Project planning, Public utility districts, Watershed management.

The El Paso (Texas) Water Utilities Public Service Board (PSB) manages a complex water distribution system for a population of more than 500,000. The water system is divided by a range of mountains that requires numerous pump stations to distribute water throughout the system. Faced with the challenge of meeting customer needs both now and well into the future, the PSB needed to develop and implement a comprehensive water system master plan to evaluate current demand on the system, to evaluate system improvement needs, and to project future demands for the planned water treatment plant. The PSB decided that the most effective means to meet the needs of El Paso both today and in the future would be an efficient, comprehensive, computerized modeling system, to be developed by outside experts but then run and managed by PSB staff on an ongoing basis. The database management system selected can be tailored to reflect specific needs, as it was in El Paso, and features the ability to link to the industry standard water distribution system model--the University of Kentucky Model (KYPIPE). The benefits of this planner are the extreme flexibility and diversity of output. PSB staff can produce maps of any or all segments of the system, allowing identification of problem areas graphically. Other benefits include the ability to maintain system records by adding to and updating the database. (Fish-PTT)
W91-04114

RADON--REMOVING IT FROM GROUNDWATER.
Hydro Group, Inc., Bridgewater, NJ. Environmental Products Div.
F. Lenzo.
Public Works PUWOAH, Vol. 121, No. 12, p 48-49, November 1990. 1 fig, 2 tab.

Descriptors: *Air stripping, *Drinking water, *Groundwater pollution, *Radon, *Radon radioisotopes, *Water treatment, *Well water, Aeration, Design criteria, Public health, Volatile organic compounds.

Radon gas contamination of groundwater supplies, and its consequent liberation into household air from the tap, is receiving well-deserved attention. The U.S. Environmental Protection Agency is considering a maximum contaminant level (MCL) in the 200 to 2,000 pCi/L range. If the MCL is at the range's lower end, as many industry experts anticipate, more than 30,000 water systems will need treatment, according to the EPA. The EPA expects to propose the MCL in early 1991, and to designate aeration as the best available technology for radon removal. High levels of radon gas trapped in household air is considered a significant health hazard. However, because radon gas is at ambient temperatures, it is easier and more economical to remove than many other volatile contaminants found in groundwater, particularly by aeration techniques. Radon 222 is a radionuclide of the uranium 238 decay series, occurring naturally in many geologic formations. It is frequently associated with radiation exposure in drinking water and in the home. Pilot study test results showed that air stripping was a feasible and cost-effective treatment for removing radon (3000 pCi/L) and tetrachloroethene (25 micrograms/L). Pilot data was compared to results from previous pilot studies and full scale systems. From this analysis, packed air stripping towers were designed to meet performance criteria while minimizing costs. Packing depth, tower diameter, and air-to-water ratio are the controlling performance factors. These parameters are interdependent, which allows the designer of the packed tower flexibility in meeting performance requirements and optimizing system capital and operating costs. (Fish-PTT)
W91-04115

SURFACE WATER DREAM TURNED INTO REALITY.
B. D. Ogea, D. Conger, and W. Moriarty.
Public Works PUWOAH, Vol. 121, No. 12, p 66-68, November 1990. 2 fig, 1 tab.

Descriptors: *Drinking water, *Surface water, *Texas, *Water resources management, *Water treatment facilities, Construction costs, Transmission lines, Water delivery, Water demand, Water supply development, Water users.

The industrial complex of Brazosport, Texas, is the largest of its kind in the nation, and the future of the community involves a secure supply of high quality drinking water. A nine-city volunteer committee recommended that a study be undertaken to guide the participating cities in the area as to whether to obtain future water form additional well fields or if the implementation of a surface water system was justified. This study recommended the treatment of Brazos River water, secured through the Dow Chemical Corporation canal and reservoir system, for conveyance to member cities. The Brazosport Water Authority (BWA) was created in 1985 to be responsible for the regional water system. Using the population, per capita residential/small commercial water usage statistics, and industrial sales, the average demand for the BWA water system was projected to the year 2020, and then the project was divided into two major elements: the water treatment plant and the transmission lines. The BWA water treatment plant was initially constructed to produce 10 mgd (average), capable of raw water pumping, coagulation, flocculation, sedimentation, filtration, disinfection, treated water storage, and high service

pumping. The water transmission system consists of 39.3 miles of 8-in to 36-in water mains, with a total construction cost of $8,808,340. The lines discharge into a storage tank at each city, where metering and flow control are provided. The water is mixed with local groundwater supplies that supplement the surface supply during peak conditions. Construction of both the water treatment plant and the transmission lines was completed and the facilities placed in service in early 1989. (Fish-PTT)
W91-04117

METAL RECOVERY USING CHITOSAN.
Protan A/S, Drammen (Norway).
For primary bibliographic entry see Field 5D.
W91-04160

ROLE OF GOVERNMENT AGENCIES IN THE FINANCING OF WATER SUPPLY SYSTEMS.
Minnesota Univ., Duluth.
For primary bibliographic entry see Field 6E.
W91-04207

VALIDATION STUDIES OF AN AUTOMATED PRECONCENTRATION WATER SAMPLER (APS) FOR CHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Ontario Ministry of the Environment, Rexdale.
For primary bibliographic entry see Field 7B.
W91-04280

DEVELOPMENT, CALIBRATION AND FURTHER DATA REQUIREMENTS OF THE SEWER FLOW QUALITY MODEL MOSQITO.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 5B.
W91-04335

GIARDIASIS OUTBREAK FROM A CHLORINATED COMMUNITY WATER SUPPLY.
South Okanagan Health Unit, Kelowna (British Columbia).
For primary bibliographic entry see Field 5B.
W91-04362

ALTERATIONS IN THE MAJOR HETEROTROPHIC BACTERIAL POPULATIONS ISOLATED FROM A STILL BOTTLED MINERAL WATER.
Coimbra Univ. (Portugal). Dept. de Zoologia.
For primary bibliographic entry see Field 5B.
W91-04368

POTENTIAL EFFECTS OF RAISING PH FOR CORROSION CONTROL ON THE AESTHETIC QUALITIES OF A WATER SUPPLY.
Whitman and Howard, Inc., Wellesley, MA.
L. E. Guilmartin, and J. B. Duggan.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 1-30, March 1990. 10 fig, 14 tab.

Descriptors: *Chemical treatment, *Corrosion control, *Hydrogen ion concentration, *Manganese, *Water quality control, *Water treatment, Aesthetics, Case studies, Chemical properties, Disinfection, Massachusetts, Phosphates, Sequestrants, Stabilization.

Some of the most common chemical and microbiological characteristics that may be affected by raising the pH for corrosion control are described, followed by a case study for the town of Wellesley, MA. Raising the pH can increase water hardness, reduce corrosive effects of carbon dioxide in the water, weaken the buffering abilities of the water, decrease the disinfection capability of chlorine and chlorine compounds, and possibly decrease the stabilizing capability of sequestering phosphate compounds. Raising the pH for corrosion control can also provide a more optimum pH for microbiological growth and cause iron and manganese (Mn) ions to oxidize more completely and rapidly to the ferric ion and manganic ion states, producing color and turbidity. The case study involved the effect of corrosion control on the sequestering of manganese in Wellesley, MA (population 27,000). Although manganese concentrations have been reduced in the water distribution, they still existed at levels averaging 0.29 mg/L (six times the maximum contaminant level for Mn). The capability of four sequestering chemicals (i.e., silicate, zinc glassy phosphate, linear chained polyphosphate, and sodium hexametaphosphate) to stabilize Mn was evaluated by performing a series of jar tests on each of the 5 well waters. Sodium hexametaphosphate was found to have fairly good stabilizing capability over a wide pH range on unheated samples, and up to a pH value of 7.5 on heated samples that were collected from most of the wells. It appeared that the sodium hexametaphosphate being used at that time to control color would continue to be effective after the implementation of a corrosion control program. In conclusion, a corrosion control program should not be developed solely on the basis of reducing the aggressiveness of a water supply. Water quality characteristics and/or distribution system conditions that may be affected by such a program must also be addressed. (VerNooy-PTT)
W91-04370

SATELLITE MANAGEMENT AND JOINT USE.
Connecticut Water Co., Clinton.
J. R. McQueen.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 31-34, March 1990.

Descriptors: *Boundary disputes, *Connecticut, *Regional planning, *Utility extension, *Water conveyance, *Water management, *Water treatment facilities, Administrative agencies, Legislation, Water policy.

In the 1985 state legislative session, the Connecticut General Assembly passed Public Act 85-535, 'An Act Concerning a Connecticut Plan for Public Water Supply Coordination.' The Act was intended to provide a coordinated approach to long-range water supply planning in an area-wide perspective with the Department of Health Services as the lead state agency. The DOHS divided the state into seven areas for this purpose and within each area a Water Utility Coordinating Committee (WUCC) was created to manage the process. Membership of the WUCC was limited to all water companies in the are, both public and private, and Regional Planning Agencies. The DOHS provided guidance to the WUCC and funding for a consultant to work with the committee. Among other activities and reports required by the Act, the WUCC was to determine Exclusive Service Area boundaries. These boundaries were to be determined by negotiation among among overlapping franchise holders, and finally adopted by the WUCC. If a boundary dispute could not be resolved by the WUCC members, the DOHS would impose a solution. Overall, the potential for future use of satellite management (or takeover of small utilities) is very great within Connecticut. Protection of raw water supplys and the routine monitoring and analysis costs will be the initial emphasis for regulatory agencies, with a substantial increase in shared laboratory facilities or satellite management undoubtedly occurring due to this reason alone. (Author's abstract)
W91-04371

ECONOMICS OF METER TESTING/CALIBRATION.
Moore and Kling, Inc., Northborough, MA.
For primary bibliographic entry see Field 6C.
W91-04372

TROUBLESHOOTING AN EXISTING TREATMENT PLANT.
Black and Veatch, Cincinnati, OH.
G. S. Logsdon, L. Mason, and J. B. Stanley.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 43-56, March 1990. 3 fig, 3 tab, 9 ref.

Descriptors: *Cryptosporidium, *Filtration, *Inspection, *Pathogens, *Pollutant identification, *Sanitary engineering, *Water treatment facilities, Flocculation, Georgia, Human diseases, Performance evaluation, Planning, Public health.

Investigating a filtration plant that is not meeting the performance criteria for turbidity or is having a problem of performance may become a more common activity if the Surface Water Treatment Rule is enacted as proposed. General guidelines art given for troubleshooting an existing treatment plant. Three categories to be considered when an engineer is called to inspect a water filtration plant include advanced preparation, on-site activities, and follow-up. During the month of January, 1987, a large number of students at West Georgia College in Carrollton, GA developed diarrhea. After the identification of Cryptosporidium in specimens, the occurrence of diarrhea in nursing home patients was also evaluated. The Centers for Disease control then contacted the US EPA for ask for assistance in evaluation of the water filtration plant. Evaluation of the conventional water filtration plant began with a tour of the facilities, followed by on-site review of the facility and operating procedures. The plant had been undergoing improvements at the time of the outbreak, and the new turbine style flocculators had not yet been installed. A list of recommendations was prepared, encompassing the following areas: raw water, rapid mix, chemical feed, flocculation, sedimentation, filter operation, filter monitoring, laboratory operations, distribution system, and operator training. More than a year has passed since the outbreak occurred, and results have been impressive. Physical and procedural plant improvements, at a modest cost, are indicative of what can be done based on a careful plant evaluation and good engineering practice. (VerNooy-PTT)
W91-04373

KEEPING YOUR NEIGHBOR HAPPY.
New Jersey-American Water Co., Shrewsbury.
W. H. Pearce.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 57-60, March 1990.

Descriptors: *Alternative planning, *Construction methods, *Project planning, *Public relations, *Water treatment facilities, Aesthetics, Environmental impact, Landscaping, Multiobjective planning, Negotiations, New Jersey, Public nuisance, Public participation, Public policy.

Since concern for the environment is becoming a pervasive and popular concern, it is no longer sufficient for engineers to design a facility which is economical, functional and technically appropriate. Considerations of location, aesthetics, impact on surroundings, possible alternative solutions and community acceptance now are equally important concerns. In 1983, the New Jersey-American Water Company, providing water service to nearly a million residents, decided to expand its existing Jumping Brook treatment plant. After a meeting with neighbors and local officials, several changes were made in construction plans to deal with concerns about traffic, noise, dust, lights, aesthetics and building heights. Trees and shrubs were planted along the lot line, all proposed structures were lowered to below 30 feet, proposed tanks were moved, and a bridge was designed to eliminate all future traffic through the residential neighborhood. Upon rejection of the new plans by the town planning board, a two part compromise was developed. The project has two sets of progress meeting each month. The first is the traditional contractor, engineer, owner meeting, with an independent arbitrator. The arbitrator, a company operations manager and a neighbor form a panel which control the project through the company. The panel meets twice a month with the neighbors, on the construction site to review upcoming activities and concerns of the neighbors. There is also a hot line to the company representative on the site for the neighbors to use. Coordination of such a complex project, along with the administration of a contractor, neighbors, and engineering has been a key part of the success. (VerNooy-PTT)
W91-04374

USE OF AIR WATER BACKWASH SYSTEMS: AN OVERVIEW.
Leopold (F.B.) Co., Inc., Ridgewood, NJ.
B. C. Slowey.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 61-68, March 1990. 5 fig, 1 tab, 10 ref.

Descriptors: *Backwash, *Filtration, *History, *Sand filters, *Water treatment, Biomass, Cleaning, Filter media, Reviews, Technology, Water conservation.

Some of the more notable improvements in the evolution of the filtration process are chronicled, emphasizing the fact that improvements and modifications are still being pursued. By 1832, the first American water treatment plant was constructed in Richmond, VA. From 1850 to 1900, the majority of the plants constructed in the US were of the 'European design, common known as slow sand filters. After this time, interest became focused upon the 'American' or rapid rate filter. During the past 75 years, changes in American water plant design have been evolutionary rather than revolutionary. The employment of agitator type mechanisms and the use of air in backwashing operations are examples of this evolution in technology. By the late '60s and early '70s, industry had become highly conscious of the environment, and conservation awareness became the watch-word for operational practices. Improvement of filtration backwash practices to remove biomass and to prevent it from plugging and fouling filtration facilities was made possible by the combined use of both air and water in the backwashing process. By introducing air during low-rate backwash, a vigorous scouring of the particles occurs, which is effective over the full depth of the filter bed. Today's technology affords three alternative approaches to the air/water backwashing of filters: nozzles; conventional filter underdrains outfitted with an air grid; and the plastic, dual-parallel system. Nozzles are made of plastic so there is no possibility of corrosion. They provide individual air metering and require less support gravel. However, there is a physical limitation to their placement, their susceptibility to plugging and they are highly labor intensive to install and maintain. Air grid systems can be retrofitted to existing systems. However, orifice plugging and maldistribution are concerns which can result in media compaction. The air grid method material (stainless steel, brass, or Schedule 80 PVC) greatly increases the cost. The plastic dual-parallel system has no small slots to be plugged and there are 22 distribution points/sq ft. It is easy to clean and is generally less expensive on an installed basis however the plastic block is more expensive and installation requires experienced supervision. Irrespective of the air scour system employed, considerable savings of backwash water are generally realized. (VerNooy-PTT)
W91-04375

OZONATION OF TRACE ORGANIC COMPOUNDS: MODEL PREDICTIONS VERSUS EXPERIMENTAL DATA.
Middle East Technical Univ., Ankara (Turkey). Dept. of Environmental Engineering.
C. Yurteri, and M. D. Gurol.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 217-229, 1990. 5 fig, 1 tab, 10 ref.

Descriptors: *Model testing, *Organic compounds, *Ozonation, *Toluene, *Wastewater treatment, *Water treatment, Experimental data, Mathematical models, Oxidation, Trace levels.

In recent years, trace quantities of numerous man-made organic compounds have been identified in water supplies throughout the world. Ozonation is one of the methods used for the elimination of man-made organic micropollutants from drinking waters and waste effluents requiring advanced treatment. A mathematical model was developed to simulate the physical transport and chemical oxidation phenomena prevailing during the process of ozonation. A packed column reactor was constructed in order to test the aptness of the process model. After determining the fluid-dynamic and mass transfer properties of the reactor, stock water solutions spiked with toluene were brought into contact with gaseous oxygen-ozone (O2-O3) mixtures. Toluene removal efficiencies observed under different experimental conditions were then compared with the model predictions. The model represented the physical and chemical phenomena of ozonation, and successfully predicted the rates of toluene removal under different conditions. The model also had success in predicting the residual dissolved ozone concentrations and ozone absorption efficiencies. In addition, the model can also be used to make cost and performance comparisons between ozonation and other alternative treatment methods. (Author's abstract)
W91-04377

WATER DISINFECTION: A RELATIONSHIP BETWEEN OZONE AND ALDEHYDE PRODUCTION.
Turin Univ. (Italy). Dept. of Hygiene and Community Medicine.
G. Gilli, E. Scursatone, L. Palin, R. Bono, and E. Carraro.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 231-241, 1990. 3 fig, 4 tab, 13 ref.

Descriptors: *Aldehydes, *Chlorination, *Disinfection, *Ozonation, *Water pollution sources, *Water treatment, Chemical analysis, Chemical reactions, Formaldehyde, Italy, Oxidation process.

In the water potabilization plant in the city of Turin (Italy), the oxidation process is carried out with ozone. Due to its well-known inefficient performance, it is necessary to add alternative oxidants (hypochlorite ion and chlorine dioxide). During surface water treatment in the Turin plant, field tests confirmed the synthesis of some aliphatic carbonyl compounds of low molecular weight (i.e., C1 to C7 carbonyls). This phenomenon happens primarily during the ozone disinfection process and, secondarily, during the other disinfection processes. Carbonyl compounds found during the two seasons studied (winter and summer) in the four sampling sites include formaldehyde, acetaldehyde, acetone, propionaldehyde, isobutyraldehyde, and n-valeraldehyde. Experimental results show that, in this last event, chlorine reacts with organic substances. If there is still a sufficient concentration of chlorine after organics consumption, the organic substances are oxidized. It will be necessary to evaluate the employment of oxidants (sites and times) in relation to further synthesis of carbonyl compounds and optimization of the oxidative destruction of these carbonyl compounds that are known to represent a health risk factor. (VerNooy-PTT)
W91-04378

COOLING WATER TREATMENT WITH OZONE.
Brown, Boveri Research Center, Baden (Switzerland).
R. Wellauer, and M. Oldani.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 243-253, 1990. 2 fig, 2 tab, 7 ref.

Descriptors: *Cooling water, *Corrosion control, *Ozonation, *Pilot plants, *Recirculated water, *Steel, *Titanium, *Water treatment, Alloys, Biocides, Chemical reactions, Chemical treatment, Chlorination, Copper.

Small scale tests on an open recirculating cooling system with a cooling water flow of 10 cu m/hour conducted for a period of two years have shown that ozone could be a viable alternative to chorine and other commonly used biocides. An average ozone dosage of 0.05 mg/L was applied continuously to the cooling water. Corrosion rates of copper alloy samples immersed in ozonized water were lower than the rates of samples in non-ionized water. No corrosion was detected for the chromium-nickel steel alloys DIN 1.4306 and DIN 1.4404 as well as for titanium in either treated or untreated water. A pilot plant has been set up at the EVS Heilbronn coal-fired power station in West Germany in order to confirm the results obtained on a small scale. The open recirculating cooling system has a cooling water flow of 1,000 cu m/hour and is fed by conditioned Neckar river water. Ozone is introduced into a 10% side stream of the cooling water by a bubble diffuser contactor. The plant can be run to yield either a constant ozone residual concentration in the water or a constant ozone dosage to the water leaving the contactor. Corrosion experiments are performed using laboratory heat exchangers, and all physical, chemical, and microbiological data of the cooling water area acquired. The operation started February 1, 1989 and is scheduled to be terminated by the end of 1990. Detailed information on the results of the investigation concerning water quality, corrosion and fouling/scaling will be given after completion of the pilot plant study. (Author's abstract)
W91-04379

ASPECTS OF OZONE GENERATION FROM AIR.
Technische Hochschule Aachen (Germany, F.R.).
D. Braun, U. Kuchler, and G. Pietsch.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 255-268, 1990. 11 fig, 8 ref.

Descriptors: *Electrical equipment, *Model studies, *Ozone, *Simulation analysis, *Water treatment, Air, Chemical reactions, Computer-aided design, Efficiency, Mathematical equations, Microdischarges, Nitrogen oxides, Optimal yield, Oxygen, Ozonation.

In many fields of industrial application including drinking water purification, the usage of ozone is a question of economics. In order to improve the efficiency of especially air-fed ozone generators, fundamental research work on modeling of microdischarges, the chemical reaction scheme, and extensive experimental investigations have been undertaken. The gas discharge in ozone generators consists of many randomly distributed transient high pressure glow discharges (microdischarges) of a few nanoseconds duration. To determine the most relevant parameters of a microdischarge, a computer simulation of a single microdischarge is performed which is based on experimental results. In the reaction phase, chemical reactions take place between particles which are produced in the discharge phase. In order to describe the overall behavior of the ozone generator theoretically, a rate equation system of 75 reactions between the different particles within the process gas has been used. The main trends in ozone generator optimization are reducing its size and enlarging its efficiency. The first aim is realized by increasing the power density to several kW/sq m, e.g., by increasing the frequency to the range of several kHz. An improvement of efficiency is possible by a proper choice of gap width, gas pressure, power frequency, and cooling conditions. The reaction temperature in the process volume and concentration of nitrogen oxides are the main factors influencing ozone yield. In order to quantify the improvement of ozone generator behavior, a theoretical modeling of the temperature within the discharge gap should be performed. For this purpose, solution of the heat conduction equation, including the influence of the microdischarges on heat conductivity, must be solved. (VerNooy-PTT)
W91-04380

MASS BALANCE ANALYSIS OF OZONE IN A CONVENTIONAL BUBBLE COLUMN.
Shanghai Coll. of Architecture and Municipal Engineering (China). Dept. of Environmental Engineering.
F. Xu, and C. Liu.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 269-279, 1990. 6 fig, 2 tab, 10 ref.

Descriptors: *Chemical interactions, *Disinfection, *Kinetics, *Mass transfer, *Model studies, *Ozonation, *Ozone, *Water treatment, Design criteria, Experimental data, Flow rates, Optimization, Organic matter, Potable water.

In water treatment, ozone has been used mainly as a disinfectant for its bactericidal and virucidal properties. At present, ozone is used increasingly for removal of organic matter from water. Ozone transfer into potable water was studied in a conventional bubble column, and ozone mass balances

have been calculated to determine ozone utilization efficiencies. Liquid and gas flow rates, as well as inlet ozone concentrations in the gas phase were varied. Using these data, it was possible to determine the ozone mass transfer coefficient, ozone water efficiency, and ozone consumption. Experimental results indicated that ozonation reaction kinetics appear to have a considerable effect on ozone mass transfer efficiency. Ozone mass transfer coefficients with ozonation reaction were large, almost twice as much as were the ozone mass transfer coefficients without ozonation reaction. However, the ozonation reaction was controlled by the ozone transfer rate. A model of ozone transfer was established, and procedures for calculating the optimum design parameters and operating conditions are proposed. An analogous procedure may be developed for existing contactors to calculate new operating conditions when water quality or liquid flow rates are changed. (VerNooy-PTT)
W91-04381

APPLICATION OF COMBINED OZONE/HYDROGEN PEROXIDE FOR THE REMOVAL OF AROMATIC COMPOUNDS FROM A GROUNDWATER.
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
For primary bibliographic entry see Field 5G.
W91-04382

EFFECT OF OZONATION ON THE REMOVAL OF ORGANICS BY COAGULATION/FLOCCULATION.
Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.
E. Lefebvre, H. Paillard, and B. Legube.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 295-313, 1990. 7 fig, 6 tab, 36 ref.

Descriptors: *Chemical coagulation, *Chemical interactions, *Flocculation, *Humic substances, *Organic compounds, *Ozonation, *Water treatment, Dissolved solids, Fulvic acids, Organic carbon, Ozone, Reservoirs.

The effects of ozonation were studied in the particular framework of the study of drinking water treatment of reservoir waters which contain high concentrations of organics, mainly humic substances. Previous studies on coagulation of fulvic acid solutions have shown that the optimal removal of organic matter was reached at acidic pH with 2 mg of ferric ion per mg of organic carbon. Accordingly, the impact of preozonation was determined on the removal of organics by iron (III) coagulation. The study of the behavior of organics, in terms of ultraviolet absorbance and total organic carbon measurements (TOC) was made on fulvic acids from three aquatic impoundments and on two sources raw water. The experiments carried out with fulvic acids showed that preozonation (at 0.5 mg O3/mg C) of fulvic acid appeared to have shifted the region of optimal dissolved organic carbon removal towards the higher coagulant dose. Furthermore, increasing ozone doses led to a slight decreasing of coagulation efficiency at constant coagulant dose. With two raw water samples, preozonation at low ozone doses (0.2 mg O3/C) was found to improve very slightly the elimination of organic matter, while high ozone doses (0.9 mg O3/mg C) led to a disturbance of TOC elimination by iron coagulation. (Author's abstract)
W91-04383

OZONATION OF SULFUR-CONTAINING ALIPHATIC COMPOUNDS IN AQUEOUS SOLUTION: I.
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. Wassertechnologie.
E. Gilbert, and S. Hoffmann-Glewe.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 315-327, 1990. 10 fig, 2 tab, 5 ref.

Descriptors: *Degradation products, *Fate of pollutants, *Hydrogen ion concentration, *Ozonation, *Sulfur compounds, *Water treatment, Chemical reactions, Chemical treatment, Kinetics, Model studies, Oxidation, Ozone.

Because ozone can react with sulfur-containing natural and anthropogenic compounds, the oxidation products of sulfur-containing aliphatic model compounds were investigated using pure water at different pH values. In the first part, thiodiglycolic acid was used as a model thioether. The rate of elimination was independent of pH-value. At pH 3, thionyldiglycolic acid is formed as a primary product, it then undergoes a very slow further oxidation to sulfone diacetic acid, which is very stable against ozone attack at pH 3. At pH 7, and higher, however, thionyldiglycolic acid is rapidly oxidized to sulfone diacetic acid, which in turn is oxidized to sulfoacetic acid, oxalic acid, glyoxylic acid, sulfate ion, and carbon dioxide after longer reaction times. In no cases, could sulfite be identified as an inorganic intermediate product. Also the intermediate products in pure solutions are ozonized. The mass balances show that 90 to 95% of the oxidation products could be identified. Based on these results, two reaction pathways can be considered: (1) In the first step, independent of pH, the thionyl ether is converted to a thionyl compound--possibly by direct ozone attack. The thionyl compound is quantitatively oxidized to a sulfone in acidic medium; (2) In neutral and basic medium, besides the thionyl oxidation, the most probable explanation is an attack on the adjacent CH2 group by OH free radicals. This should be the case at pH 9.5 where the compound is oxidized to organic acids and sulfate ions. The conversion of organic-bound sulfur atoms into their mineralized form under normal drinking water ozonation conditions is therefore unlikely, and only possible at high pH values. (VerNooy-PTT)
W91-04384

QUINOXALINE OZONATION IN AQUEOUS SOLUTION.
Naples Univ. (Italy). Ist. di Ricerche sulla Combustione.
R. Andreozzi, V. Caprio, M. G. D'Amore, and A. Insola.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 329-340, 1990. 5 fig, 10 ref.

Descriptors: *Fate of pollutants, *Nitrogen compounds, *Ozonation, *Quinoxaline, *Water treatment, Chemical reactions, Data interpretation, Experimental data, Hydrogen ion concentration, Kinetics, Oxidation process, Ozone.

Aqueous solutions of heterocyclic nitrogen compounds are often found as micropollutants in drinking water. Accordingly, the oxidation of quinoxaline by ozone in aqueous solution was investigated. The chemical and kinetic evolution of the oxidation process at varying pH is followed by means of semi-batch ozonation experiments. Results indicated that quinoxaline ozonation can be sustained by either free-radical or ionic ozonation mechanisms, the ratio of which can be varied by means of addition to the reacting system of radical scavengers or ozone decomposition promoters. Each mechanism involves an initial attack of ozone to both the homocyclic and heterocyclic rings of quinoxaline. Pyrazinedicarboxylic acid is produced in the course of either course of oxidation; it is stable toward further ionic ozonation, whereas it still reactive towards ozone in radical ozonation. Radical ozonation is directed more favorably toward homocyclic ring cleavage than ionic ozonation. The yields of pyrazinedicarboxylic acid are thus higher in radial ozonation, despite its reactivity toward ozone. Pyrazine, however, is sensitive only to radical ozonation while the pyrazinic ring of quinoxaline is also sensitive to ionic attack by ozone because of the activating influence of the fused benzene ring. (VerNooy-PTT)
W91-04385

FAECAL CONTAMINATION OF WATER AND FINGERTIP-RINSES AS A METHOD FOR EVALUATING THE EFFECT OF LOW-COST WATER SUPPLY AND SANITATION ACTIVITIES ON FAECO-ORAL DISEASE TRANSMISSION. I. A CASE STUDY IN RURAL NORTH-EAST THAILAND.
Leeds Univ. (England). Dept. of Civil Engineering.
J. V. Pinfold.
Epidemiology and Infection EPINEU, Vol. 105, No. 2, p 363-375, October 1990. 2 fig, 5 tab, 29 ref.

Descriptors: *Developing countries, *Domestic water, *Feces, *Human diseases, *Human pathogens, *Path of pollutants, *Public health, *Sanitation, *Thailand, *Water pollution sources, *Water use, Bacterial analysis, Contamination, Drinking water, Escherichia coli, Salmonella, Sanitary wastewater.

Most villagers in north-east Thailand carry water to their homes and store it in separate containers depending on its subsequent use. In one village, information on water use was collected, including the bacteriological quality of stored water, water sources and fingertip rinses. Stored water quality was a function of water-related activities rather than quality at source ($P < 0.0001$). Specifically, water used for toilet, washing dishes and cooking-related activities was much more contaminated with fecal bacteria than that used for drinking and cooking. Salmonella spp. was significantly more common in water used for washing dishes than drinking water ($P < 0.05$). Escherichia coli contamination of fingertip rinses was strongly associated with the individual's activity prior to testing ($P<0.0001$); child care, food and water-related activities produced much higher levels of fingertip contamination than others. Dirty utensils used for cooking and eating were usually left to soak and fecal bacterial growth occurred in this grossly contaminated soak water. Cross-contamination via water handling was the main mechanism of stored water pollution. (See also W91-04457) (Author's abstract)
W91-04456

FAECAL CONTAMINATION OF WATER AND FINGERTIP-RINSES AS A METHOD FOR EVALUATING THE EFFECT OF LOW-COST WATER SUPPLY AND SANITATION ACTIVITIES ON FAECO-ORAL DISEASE TRANSMISSION. II. A HYGIENE INTERVENTION STUDY IN RURAL NORTH-EAST THAILAND.
Leeds Univ. (England). Dept. of Civil Engineering.
J. V. Pinfold.
Epidemiology and Infection EPINEU, Vol. 105, No. 2, p 377-389, October 1990. 3 fig, 5 tab, 8 ref.

Descriptors: *Contamination, *Developing countries, *Domestic water, *Drinking water, *Feces, *Human diseases, *Human pathogens, *Path of pollutants, *Public health, *Sanitation, *Thailand, *Water pollution, *Water pollution sources, *Water use, Education, Escherichia coli, Fecal coliforms, Risk assessment, Seasonal variation.

An intervention study was developed from risk-factors associated with feco-oral transmission, based on the levels of contamination in stored water and fingertip rinses from households in rural north-east Thailand, designed to improve (a) hand-washing, particularly before cooking/eating and after defecation; (b) washing dishes immediately after use. Verbal messages were administered to two intervention groups, one also received a plastic container with a tap to assist these activities. Indicators of compliance were the direct observation of soaking dishes and the presence of fecal streptococci from fingertip rinses; the main outcome indicator was Escherichia coli contamination of stored water. The control for indicators of compliance ($P<0.001$ and $P<0.01$) and its stored water was significantly less contaminated ($P<0.001$). No significant improvement in the other intervention group was noted, although some features of the intervention had clearly been made available to the control group. Humidity was significantly correlated with fingertip contamination ($r=0.2$; $P<0.001$) and with the peak of reported diarrhea around the beginning of the rainy season. (See also W91-04456) (Author's abstract)
W91-04457

REALIZING THE BENEFITS OF WATER REUSE IN DEVELOPING COUNTRIES.
Camp, Dresser and McKee, Inc., Raleigh, NC.
For primary bibliographic entry see Field 3C.

W91-04604

U.S. WATER REUSE: CURRENT STATUS AND FUTURE TRENDS.
CH2M/Hill, Denver, CO.
For primary bibliographic entry see Field 3C.
W91-04605

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 70--JUL 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-866701. Price codes: N01 in paper copy, N01 in microfiche. August 1989. 94p.

Descriptors: *Bibliographies, *Drinking water, *Heavy metals, *Path of pollutants, *Water distribution, *Water pollution sources, *Water treatment, Pipelines, Plumbing, Public health, Standards, Water quality control.

This bibliography contains citations concerning the presence of heavy metals in drinking water. The effects of plumbing systems on water quality is discussed. Standards for safe drinking water are included. Treatment techniques to remove heavy metals are described. Methods for analyzing heavy metal contaminants in water are presented. The effects of heavy metals in drinking water on human health are briefly considered. (This updated bibliography contains 188 citations, 29 of which are new entries to the previous edition.) (Author's abstract)
W91-04650

WATER QUALITY STANDARDS (JAN 70--MAY 89).
National Technical Information Service, Springfield, VA.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-862601. Price codes: N01 in paper copy, N01 in microfiche. June 1989. 36p.

Descriptors: *Bibliographies, *Standards, *Water quality, *Water quality standards, *Water treatment, Arsenic, Bacteria, Cyanide, Dissolved oxygen, Dissolved solids, Heavy metals, Hydrogen ion concentration, Iron, Mercury, Organic compounds, Pesticides, State jurisdiction, Zinc.

This bibliography contains citations concerning compilations of water quality standards for the United States and the U.S. territories. Individual chemical and biological species such as organics, mercury, bacteria, cyanide, arsenic, zinc, pesticides, and iron are discussed. Standards for such properties as pH, temperature, dissolved solids, dissolved oxygen, and material degradation are included. State water quality standards are included, and are listed separately. Heavy metal pollution and water quality legislation are discussed in separate bibliographies. (Contains 100 citations) (Author's abstract)
W91-04651

POTABLE WATER FOR THE DEVELOPING WORLD -- SOME OF THE PROBLEMS.
Loughborough Univ. of Technology (England). Dept. of Civil Engineering.
K. V. Ellis.
Aqua AQUAAA, Vol. 39, No. 6, p 368-375, December 1990. 5 ref.

Descriptors: *Developing countries, *Potable water, *Water delivery, Bottled water, Hand pumps, Information exchange, Pumps, Water management, Water resources development, Water scarcity, Water supply development, Water treatment.

Although major advances have been made in recent years in the provision and treatment of water in the developing world, the growth of the population has continually placed the target of good-quality water for all just as far away as ever. Lack of money remains the principal, perennial problem in all situations. Other major problems include training, research and dissemination of information; planning and design of treatment and supply projects; proper operation, control and monitoring of established systems; standardization of equipment and transport; distribution problems; and policies surrounding use of bottled water. Training of engineers and of technicians to cope effectively and imaginatively with the peculiar and diverse problems of water treatment and supply in the developing world is of paramount importance. With designs, it is not sufficient merely to duplicate the designs of the developed world or even to search for the simplest and cheapest technology. It is necessary that the technology appropriate to the particular situation be selected, that the planning and design stages be carried out by people experienced in the problems of the developing world and that at this stage the influences of ill-informed civil servants and politicians be kept to a minimum. Treatment and supply of potable water in developing countries depends on the availability of spare parts for mechanical equipment and upon the ability of the available skilled or semi-skilled mechanics to fit them. Hand-pumps are useful for small-scale supplies and should be standardized in any one area or country. A particular challenge with handpumps is to select one model for any particular locality which is at the same time reliable, inexpensive, requiring only a limited number of spare parts and which is readily maintainable by non-skilled mechanics. The problem of bottled water is an insidious one. It is not unknown for such water to cost more per liter than petrol and hence cannot be afforded by the poorer elements of society. (Mertz-PTT)
W91-04755

CONCERNS WITH USING CHLORINE-DIOXIDE DISINFECTION IN THE USA.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
B. W. Lykins, J. A. Goodrich, and J. C. Hoff.
Aqua AQUAAA, Vol. 39, No. 6, p 376-386, December 1990. 9 fig, 6 tab, 33 ref.

Descriptors: *Chlorine, *Disinfection, *Drinking water, *Trihalomethanes, *Water treatment, Activated carbon, Biocides, Chlorine dioxide, Organoleptic properties, Public health, Regulations.

There is renewed interest in disinfection with chlorine dioxide in the U.S. because of upcoming Federal regulations on disinfection by-products. Bench studies and field applications of chlorine dioxide have shown that it is an effective biocide that does not produce halogenated by-products such as trihalomethanes. There are some health concerns with ingesting chlorine dioxide and it metabolites, chlorite and chlorate, and concerns about tastes and odors. Residual concentrations of less than 0.5 mg/L were recommended in the trihalomethane final rule for the total oxidants of chlorine dioxide, chlorite and chlorate. Others have recommended 1.0 mg/L. These concerns may be alleviated by removing the chlorine-dioxide species with granular activated carbon or reducing them to chloride before water distribution. A research project by EPA with the Evansville, Indiana Water Department has been initiated to evaluate this possibility. Parallel treatment trains will evaluate granular activated carbon and reducing agents. One train will consist of producing chlorine and chlorate free chlorine dioxide with the chlorine dioxide and chlorate reduced by the addition of a reducing agent producing no or low concentrations of chlorine-dioxide oxidants. Another disinfectant such as free or combined chlorine is needed to maintain a residual in the distribution system. (Mertz-PTT)
W91-04756

THEORY AND PERFORMANCE OF A JET-MIXED SEPARATOR.
Miyazaki Univ. (Japan). Dept. of Civil Engineering.
Y. Watanabe, M. Fukui, and T. Miyanosita.
Aqua AQUAAA, Vol. 39, No. 6, p 387-395, December 1990. 16 fig, 1 tab, 9 ref.

Descriptors: *Flocculation, *Sand filters, *Water treatment, Jet-mixed separators, Sedimentation, Separation techniques, Solid-liquid separators, Suspended solids, Wastewater treatment.

In rapid sand filtration systems, mechanical flocculators with paddles followed by gravity settlers have been used to reduce suspended solids loading on the sand filters. In the mechanical flocculators, turbulent flow produced by paddle mixing promotes floc growth and prevents the settling for grown-flocs. The performance of a jet-mixed separator was examined. The jet-mixed separator has a series of porous plates inserted in the channel perpendicular to a flow. The water passes through holes in the plates, thus creating jets which gently mix the water on itself. Simultaneous flocculation of suspended particles and sedimentation of grown-flocs occurred in the jet-mixed separator, because large-scale eddies in the vertical plane were almost absent in it. In the case of concentrations of influent suspended particles of 25-50 microgram/g and hydraulic detention times of 30 minutes, the effluent suspended particle concentration using the jet-mixed separator was reduced to about 5 microgram/g. The jet-mixed separator is an economical and effective solid-liquid separator. (Mertz-PTT)
W91-04757

COMPARATIVE EVALUATION OF TWO NOVEL DISINFECTION METHODS FOR SMALL-COMMUNITY WATER TREATMENT IN DEVELOPING COUNTRIES.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
L. P. Barrott, B. J. Lloyd, and N. J. D. Graham.
Aqua AQUAAA, Vol. 39, No. 6, p 396-404, December 1990. 6 fig, 3 tab, 14 ref.

Descriptors: *Developing countries, *Disinfection, *Water treatment, Iodine, Membranes, Oxidation, Physicochemical treatment, Resins, Rural areas.

Disinfection is a vital part of water treatment but water supplies in developing countries are frequently not disinfected, or disinfection fails and the water remains contaminated. Many factors contribute to this failure including lack of resources, equipment, transport and trained personnel, especially in small communities in rural areas. Two novel disinfection methods, the Moggod (mixed oxidant gases generated on demand) and an iodinated resin cartridge, were assessed in terms of their operational performance, reliability and chemical and power consumption in comparison with a conventional hypochlorite doser. The Moggod has considerable potential for use in developing countries. It is easy to use, reliable and robust. The running costs are low and the consumables, salt and water, are easy to obtain. There is an enhanced reactivity of the chlorine produced by the Moggod although the reason for this is not clear. A vital aspect of the performance of the Moggod is the effect of low-quality salt on the membrane. It is expected that the use of low-quality salt would eventually block the membrane and that the length of time between cleaning the membrane in the Moggod depends on the quality of salt and water used. The commercial resin that was tested was not successful as a disinfection method under the conditions of the pilot-plant experiment, the iodine was released too quickly and bacterial breakthrough occurred. Iodinated charcoals offer more hope of success. They can be produced in developing countries from a wide range of local materials. (Mertz-PTT)
W91-04758

WATER QUALITY IN FINLAND.
J. Liimatainen.
Aqua AQUAAA, Vol. 39, No. 6, p 405-406, December 1990.

Descriptors: *Finland, *Water quality, *Water quality control, *Water treatment, Fluorides, Groundwater quality, Hydrogen ion concentration, Iron, Organic matter, Water quality standards, Water resources.

Finland has a population of 5 million and a total area of 337,000 sq km. The mean annual temperature at the coastal south-west area is about +5 C

and in the north (Lapland) about -2 C. In summer the mean temperatures are +15-17 C and highest midday temperatures around 35 C. There are about 55,000 lakes in Finland. The area of inland water courses is nearly 10% of the total area. The lakes are relatively shallow, with a mean depth of about 7 m. Watercourses are frozen for 100-200 days per year. The most common type of soil is moraine, which is unassorted stone and sand of all sizes. It forms a poorly permeable layer at the bedrock. The most useful groundwater tables are around gravel ridges. The Finnish potable water quality requirements are quite similar to WHO (World Health Organization) standards. The results of analyses show that in 1987 1% of water delivered did not always meet the health criteria and 7% of water delivered did not meet the secondary criteria. Fluoride at groundwater treatment plants was the most common cause for not meeting the health criteria. Iron and pH values at groundwater treatment plants and organic matter and color at surface water treatment plants were the main reason for not meeting the secondary quality criteria. During the past few years the following measures have been taken at all or some water works to improve the quality of water supplied: organic compounds have been decreased by optimizing treatment process and by introducing double coagulation with aluminum and iron salts; organic chlorine compounds have been decreased; lime and carbon dioxide are used for corrosion control; flotation is used instead of sedimentation; and the use of natural or artificial groundwater has decreased the need for chemical water treatment. (Mertz-PTT)
W91-04759

USE OF PERVAPORATION FOR THE REMOVAL OF ORGANIC CONTAMINANTS FROM WATER.
Zenon Environmental, Inc., Burlington (Ontario).
C. Lipski, and P. Cote.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 254-261, November 1990. 3 fig, 7 tab, 14 ref.

Descriptors: *Membrane filters, *Pervaporation, *Volatile organic compounds, *Wastewater treatment, *Water treatment, Chlorinated hydrocarbons, Cost analysis, Cost comparison, Groundwater pollution, Leachates, Organic compounds, Separation techniques, Silicone.

Pervaporation is a new membrane process for the removal and concentration of volatile organic compounds from contaminated water. It can be used to treat groundwater, leachate, and wastewater. A resistance-in-series model was formulated and validated using silicone rubber hollow fibers for the treatment of water containing trichloroethylene. This process model was coupled with a costing model to assist in the design of pervaporation systems. High fluxes and separation factors were obtained for the removal of trichloroethylene from water using a thick silicone rubber membrane. Two different membrane configurations were tested using the same hollow fibers. Pervaporation was described by a resistance-in-series model: a liquid film resistance and a membrane resistance. Estimation of the two resistances showed that, for the trichloroethylene, mass transfer was limited by the liquid film resistance from an inside flow module. Membrane resistance only became apparent for a transversal flow module. A pervaporation case study of trichloroethylene demonstrated that the flux of trichloroethylene was a function of both the membrane thickness and module hydrodynamic conditions. A case study found that the pervaporation unit treatment cost was $0.56/cu m for the transversal flow module, $1.10/cubic m for the spiral-wound module, $1.41/cu m for the inside flow module (wide bore fibers) and $3.80/cu m for the inside flow module (narrow bore fibers). For comparison, the cost of conventional technologies ranged from $0.10/cubic m, for air stripping alone, to $0.80/cubic m, for treatment trains including stripping and/or granular activated carbon on the aqueous or off-gas streams. In addition to the fact that pervaporation has definite technical advantages over conventional processes, it appear pervaporation has a economic advantage as well. (Mertz-PTT)
W91-04771

RADON IN THE HUMAN BODY FROM DRINKING WATER.
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 5B.
W91-04777

LEGIONELLA IN DUBLIN HOSPITAL WATER SUPPLIES.
Mater Misericordiae Hospital, Dublin (Ireland). Dept. of Microbiology.
C. Haugh, R. Hone, and C. J. Smyth.
Irish Journal of Medical Science IJMSAT, Vol. 159, No. 1, p 10-13, January 1990. 2 fig, 21 ref.

Descriptors: *Hospitals, *Ireland, *Legionella, *Potable water, *Water conveyance, *Water pollution, Bacteria, Human diseases, Pathogenic bacteria, Water sampling, Water tanks.

Legionella pneumophila was first recognized as the etiological agent of Legionnaires' disease following a mysterious outbreak of pneumonia at an American Legion Convention in Philadelphia in 1976. Early studies suggested that infection was due to inhalation of the organism. Since then, many other outbreaks of Legionella pneumonia have occurred both in the United States and Britain. Investigations following these outbreaks have shown that water distribution systems, humidifiers and air-conditioning systems can serve as the source and means of spread of Legionella. However, L. pneumophila has also been isolated from potable water in buildings with no associated cases of legionellosis. An environmental survey was carried out which consisted of periodic and random sampling of water tanks and showers in two large Dublin hospitals. Of the samples, 5.3% yielded Legionella bacteria. Legionella pnuemophila of serogroups 3,5, and 6 were isolated from these sites with viable counts ranging from 300-2500 c.f.u./liter. The implementation of periodic sampling may, however, not be a worthwhile exercise unless an environmental site has been associated with cases of legioneilosis. Emphasis should be placed on the prevention of contamination of environmental sites with legionellae and on the development and implementation of protocols and procedures for the isolation of legionellae to gain the necessary expertise should an epidemiological survey be required. (Mertz-PTT)
W91-04778

ACUTE EPIDEMIC ALUMINIUM OSTEOMALACIA SECONDARY TO WATER SUPPLY CONTAMINATION.
Meath Hospital, Dublin (Ireland). Dept. of Clinical Medicine.
For primary bibliographic entry see Field 5C.
W91-04779

TASTE AND ODOR EPISODES AT WACHUSETT RESERVOIR.
Massachusetts Water Resources Authority, Boston. Harbor Studies Dept.
W. Sung.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 165-178, September 1990. 9 fig, 1 tab, 6 ref.

Descriptors: *Algae, *Chrysophyta, *Massachusetts, *Odor-producing algae, *Organoleptic properties, *Reservoirs, *Taste-producing algae, Copper sulfate, Phosphorus, Silica, Synura, Wachusett Reservoir.

The Metropolitan District Commission (MDC)/ Massachusetts Water Resources Authority (MWRA) system experienced a severe taste and odor episode in their drinking water that lasted from the fall of 1987 to the spring of 1988. The causal agent of the episode was attributed to the growth of the alga Synura petersenii at the Wachusett Reservoir in Clinton, Massachusetts. The reservoir is classified as a dimictic water body with a uniform water column temperature of about 5 C after the spring thaw and a surface water temperature of 18 C by June 8. Copper sulfate treatments were not successful in controlling the taste and odor problem either because of insufficient dosage after mixing in the water column, or because the algae released their compounds after they were lysed by the copper. A final report issued in January 1989 suggests that a phosphorus build-up may have contributed to the Synura outbreak. It was further suggested that silica as a trace nutrient may be a factor in the Synura growth. (White-Reimer-PTT)
W91-04840

RETROFIT OF PULSATOR TYPE UPFLOW CLARIFIERS WITH TUBE SETTLERS.
Pennichuck Water Works, Inc., Nashua, NH.
B. J. Rousseau, and W. J. Nunnery.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 179-191, September 1990. 5 fig, 5 tab.

Descriptors: *Clarifiers, *New Hampshire, *Tube settlers, *Water treatment, Performance evaluation, Pulsator upflow clarifiers, Retrofitting, Treatment capacity.

The Pennichuck Water Works, in the City of Nashua, New Hampshire, was able to increase its maximum day treatment capacity to 35 MGD by installing tube settlers in its existing Pulsator Clarifiers. This retrofit allowed the clarification units to be loaded at the required design rise rate of 1.75 gpm/sq ft during the summer months. As the flow to the clarifier unit was increased, it was observed that the sludge blanket started to carry-over at the outer walls and under the walkways where there is a gap in the tube settlers. When maximum rise rates were achieved, the sludge blanket had risen above the top of the tube settlers but was below the collector pipes. Performance tests conducted during this evaluation indicated that the retrofitted units could be consistently loaded to a rise rate of 1.5 gpm/sq ft during cold water conditions and a rise rate of up to 1.8 gpm/sq ft during warm water conditions. (Author's abstract)
W91-04841

PROTECTING WATER QUALITY IN CAMBRIDGE: THE DESIGN OF THE PAYSON PARK RESERVOIR COVER.
B. D. Buckley, M. G. McArdle, M. J. Ashe, and J. J. Cusack.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 195-207, September 1990. 8 fig.

Descriptors: *Massachusetts, *Reservoir covers, *Reservoirs, *Storage reservoirs, *Water quality control, *Water supply, Cambridge, Design criteria, Economic aspects, Regulations.

The Payson Park Reservoir is an earthen embankment reservoir located on a 10-acre site in the town of Belmont, Massachusetts that supplies water to the city of Cambridge. In October 1986, the state issued a 'notice of non-compliance' to the city, stating that all treated water storage reservoirs must be covered in accordance with new safe drinking water regulations. Therefore, a report was prepared to evaluate several alternative methods in order to determine a cost-effective system for covering the reservoir. The systems evaluated included: (1) an aluminum roof deck over the existing basins; (2) a fiberglass roof deck over the existing basins; (3) precast, prestressed concrete tanks inside the existing basins; (4) a floating cover; and (5) two reinforced cast-in-place concrete tanks inside existing basins. Despite the expense, the cast-in-place reinforced concrete tank option was selected because: (1) it was the most aesthetically pleasing to the town of Belmont; (2) it has the longest life; (3) it requires the least maintenance; (4) it would be the most secure facility; and (5) it was the only alternative that eliminated the designation as a 'high hazard facility.' In developing the design criteria the city of Cambridge's storage requirements and reservoir capacity, constraints imposed by the physical environment of the existing storage facility, and aesthetic design considerations of the projects location in a residential neighborhood were the major concerns. Permits were obtained, neighborhood negotiations conducted, and the final 'memorandum of understand-

ing' between Belmont and Cambridge was executed on December 5, 1989. (White-Reimer-PTT)
W91-04842

OZONATION AN ATTRACTIVE OPTION FOR GROUNDWATER SYSTEM.
BCM Engineers, Pittsburgh, PA.
D. Slagle.
Public Works PUWOAH, Vol. 121, No. 13, p 45-46, December 1990.

Descriptors: *Design criteria, *Ozonation, *Pennsylvania, *Water treatment, *Water treatment facilities, Estimated costs, Groundwater pollution.

Ozonation, popular in Europe for over 80 years, is now being recognized in the U.S. as a viable solution to many of the challenges facing water treatment officials in the years ahead. The Municipal Authority of Harmar Township was the first water authority in Pennsylvania to construct an ozonation-filtration system. The groundwater source met the primary and secondary concentration levels allowed by the Pennsylvania Safe Drinking Water Act except for concentrations of iron and manganese which exceed secondary levels. The water also contains trace quantities of benzene, trichloroethylene, and relatively high levels of total organic carbon. A pilot plant containing an air preparation unit, an ozone generator, an ozone contact chamber constructed of a PVC pipe, and a filter unit containing conventional sand and gravel media indicated this system would be practical and cost-effective. The new ozonation plant was completed in 1990 with an initial capacity of 0.9 mgd, expandable to 1.3 mgd. The plant is fully automated, requiring virtually no on-site operation. The ozone generator is automatically controlled by an off-gas monitor that varies the amount of ozone produced according to water demand. Each of the generator's 29 dielectrics is separately fused, enabling one to fail without affecting the others. Because ozone can be lethal if it is no handled properly, the entire containment structure is built of welded stainless steel. The system also has safety mechanisms that shut it down if too much ozone is produced. Maintenance costs are projected at $3,000 for the first year. (White-Reimer-PTT)
W91-04850

PERVAPORATION OF AQUEOUS ETHANOL MIXTURES THROUGH POLY(DIMETHYL SILOXANE) MEMBRANES.
Manhattan Coll., Bronx, NY. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-04907

5G. Water Quality Control

PROTECTING GROUND WATER FROM THE BOTTOM UP: LOCAL RESPONSES TO WELLHEAD PROTECTION.
Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Sponsored by EPA Region I, Underground Injection Practices Council Research Foundation, and New England Water Works Association. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. 327p.

Descriptors: *Governmental interrelations, *Groundwater management, *Groundwater pollution, *Legal aspects, *Legislation, *Local governments, *New England, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Connecticut, Groundwater resources, Maine, Massachusetts, New Hampshire.

The 1986 Amendments to the Safe Drinking Water Act formalized the concept of State Wellhead Protection Programs to protect wellhead areas to public water supply wells from contamination. In New England, more than 50% of the region's drinking water comes from underground sources, whereas residents in rural areas are nearly 100% dependent. In recent years, hundreds of water supply wells in New England have been shut down due to contamination. Although there are numerous federal and state regulations that prevent contaminants from entering the ground, much of the power to protect water supplies rests at the local level. This groundwater conference on wellhead protection programs, held at Danvers, MA on October 2-3, 1989, was designed to share experiences gained both nationally and regionally and to develop a better understanding of the technical and regulatory interrelationships involved in protecting New England's groundwater resources, now and for the future. Papers were presented by Federal and state environmental agency staff, private consultants, academics, and local water resource managers. Topics included development of local wellhead protection plans, coordination between agencies to implement wellhead protection plans, sources of pollution, methods of determining the zone of contribution to water supply wells, the influence of non-point sources of contamination, underground tank regulations, private well regulations, injection well regulatory programs, septic tanks, and other topics concerned with wellhead protection. Many local case histories were used to illustrate the roles of Federal, state and local agencies. (See W91-03921 thru W91-03943) (Tappert-PTT)
W91-03921

DEVELOPING AND PASSING STATEWIDE WELLHEAD PROTECTION PROGRAMS CONNECTICUT: A CASE STUDY.
Murtha, Cullina, Richter and Pinney, Hartford, CT.
E. J. Brown.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 3-30. append.

Descriptors: *Connecticut, *Legal aspects, *Legislation, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Groundwater management, Groundwater resources.

Designing a comprehensive statewide wellhead protection program which is effective, workable, and politically feasible poses serious challenges to any state. The process is particularly difficult for those regions such as the northeast where the general public has yet to be concerned with severe shortages or widespread contamination of their drinking water supplies. In Connecticut, a legislative task force supported by a committed Department of Environmental Protection and spearheaded by strong legislative leadership proved to be an effective mechanism for generating the structure of their aquifer protection program. A key to the success of the Connecticut program was the team approach, whereby members of the legislative body, state environmental agency, and representatives of other interested political, technical, and civilian groups formed a task force to advise the legislature on how to address the issue of protecting groundwater resources. The task force should have at least one full-time staff member to coordinate activities and generally act as a vehicle of communication for the task force co-chairs. Additional resources available to the task force include lobbyists, municipalities, and private consultants as well as a staff attorney. An annual report should be prepared for each legislative session to document the work and proposals of the task force and help define future challenges. The writing of the actual legislation should emphasize technical correctness as well as readability. It is important to facilitate the inevitable changes that will result from the legislative process. Cooperation between task force staff and legislative staffs is critical to anticipating procedural problems and addressing challenges to the bill. In Connecticut, most of the major concerns regarding the bill were identified prior to the start of debate on the floor of the House. Ultimately HB 6594, 'An Act Concerning Aquifer Protection Areas, and Local Flood and Erosion Control Boards.' (included as appendix) unanimously passed the House of Representatives 137-0 and quickly won unanimous approval in the Senate after a predictably short debate. (See also W91-03921) (Tappert-PTT)
W91-03922

WALPOLE BOARD OF HEALTH: GROUNDWATER PROTECTION PLAN IMPLEMENTATION.
Walpole Board of Health, MA.
R. Chapell.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 31-35.

Descriptors: *Groundwater management, *Groundwater quality, *Legal aspects, *Local governments, *Massachusetts, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Groundwater, Groundwater pollution, Groundwater resources.

Towns and cities need to protect themselves from environmental degradation at the local level, without waiting for state and federal agencies to do the work. In Massachusetts local Boards of Health are charged under Massachusetts General Laws Chapter III Section 31 with protecting the public health of their communities. The Walpole Board of Health has instituted and regulated many programs to protect the town water supply from contamination. Walpole petitioned the United States Environmental Protection Agency to be designated as a sole source aquifer district, so that certain state and federal projects can be closely scrutinized for detrimental impacts upon the underlying aquifer. Prior to the sole source aquifer designation, the town hired a consultant to delineate Water Resource Protection Districts in the town. The Board of Health has used this information when reviewing preliminary plans for development. As a result, the Board has restricted uses, turned down plans, and required monitoring programs to collect information on a regular basis to ensure that particular landfills and industries in sensitive areas are not contaminating groundwater. The Board has adopted Underground Storage Regulations, Toxic and Hazardous Materials Regulations, Private Well Regulations, and Mandatory Sewer Connection Regulations. The Health Department has organized Household Hazardous Waste Collection Days to help alleviate a certain amount of illegal dumping. The department has been responsible for removal or testing of many residential underground tanks. The Board of Health strengthened Title V by requiring an increased setback from wetlands for septic systems. The Board follows up on leads concerning illegal dumping, business practices that may harm the environment, and accidental spills. With little dissension, the local residents and businesses have complied with Board actions and have taken an active role in protecting Walpole's groundwater resources. (See also W91-03921) (Tappert-PTT)
W91-03923

MODEL FOR RURAL COMMUNITIES TO ASSESS THREATS TO GROUND WATER QUALITY.
Franklin County Planning Dept., Greenfield, MA.
L. Rubinstein.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 53-69. 1 fig, 2 append.

Descriptors: *Groundwater pollution, *Groundwater quality, *Massachusetts, *Risk assessment, *Rural areas, *Water pollution control, *Water pollution prevention, *Water pollution sources, *Well regulations, *Wellhead protection, Groundwater, Groundwater management, Groundwater resources, Legal aspects.

Rural communities which rely exclusively on private water supplies, and which rely on volunteer town boards with no professional staff, often face more difficulty in identifying threats to their groundwater quality than do communities which

have access to professional assistance and public funding for protection of their water supplies. The key reason for the frequent inability of rural communities to assess threats to their groundwater is a lack of financial resources to hire professionals to conduct the evaluation. A year long effort in the town of Conway, Massachusetts demonstrated that it is possible for a volunteer effort to produce an in-depth and valuable groundwater risk assessment. The project was funded through the EPA 205J program and was designed to conduct a groundwater risk assessment in a rural setting, using only volunteer effort and little or no funding. Conway is a rural hilltown community in western Massachusetts with a population of 1,300 people and a area of 40 square miles. It relies entirely on private wells for its drinking supply and has no professional staff supporting town government. Businesses in town are primarily agriculture, a heavy equipment supplier, food processing, and small scale auto repair. It is a community of well educated, environmentally concerned citizens who are worried about the health and safety of their water supply. Included in the volunteer effort were a town wide survey, door-to-door interviews, mapping, historic records review, geologic examination, public meetings and presentations. and a final report and recommendations. The intent of the survey was to locate all wells, septic systems, underground storage tanks, abandoned wells, and land uses. The one-on-one interviews were critical for gathering information as well as public outreach and participation. Existing documents were used for identifying the geology and hydrology of the community. After identifying their aquifers and potential threats to groundwater quality, final recommendations were developed for future action by the town. These recommendations included a program of water quality testing and amendments to board of health regulations and zoning. (See also W91-03921) (Author's abstract)
W91-03925

FOX(BOROUGH) GUARDING THE AQUIFER COOP: LOCAL CONTROL AT WORK.
S E A Consultants, Inc., Cambridge, MA.
K. D. Noake.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 71-101. 8 fig, 2 tab, 13 ref.

Descriptors: *Computer models, *Groundwater management, *Groundwater quality, *Legal aspects, *Legislation, *Local governments, *Massachusetts, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Groundwater, Groundwater pollution, Groundwater resources, MODFLOW model.

Both the elected officials and citizens of the Town of Foxborough, Massachusetts have made a serious commitment to groundwater quality protection and management of potential contamination sources. Foxborough's wellhead protection strategy evolved over a five year period in response to local needs. The delineation of a wellhead protection area depends upon the hydrogeologic characteristics of the aquifer, the pumping rate and number of wells, and the amount of recharge the aquifer receives. Foxborough recognized the importance of local resource-based groundwater protection five years ago when it delineated its wellhead protection areas and adopted a Water Resource Protection District bylaw in 1984. The town retained a consultant to update the 1984 bylaw and redefine the wellhead protection areas to conform with recently adopted state guidelines for delineating primary (Zone II) and secondary (Zone III) aquifer recharge areas. The goal was to have a technically defensible wellhead protection strategy. Several carefully tailored approaches were used to delineate the recharge areas for 11 existing wells and 6 proven well sites. Monitoring wells were installed and performance tests conducted at each of the town's pumping stations using an automated data gathering and processing system. The database was used in a detailed aquifer simulation model (MODFLOW) which delineated the recharge areas for the 17 wells. Existing pumping test data was re-evaluated using current computer programs and incorporated into the model when necessary. A mass balance nitrate loading model was used to determine the nitrate loading in the Zone II areas under maximum build-out conditions. A new Water Resource Protection District bylaw was written to protect both the Zone II and Zone III areas. The bylaw includes a comprehensive list of prohibited uses and uses that were allowed by special permit subject to stringent performance standards. To further strengthen the town's wellhead protection strategy, the consultant wrote a new Toxic and Hazardous Materials bylaw, recommended changes to subdivision rules and Board of Health regulations, and designed a groundwater monitoring program. (See also W91-03921) (Author's abstract)
W91-03926

EASTON'S EXPERIENCE AND THE CANOE RIVER AQUIFER ADVISORY COMMITTEE.
Easton Water Div., MA.
W. P. Southworth.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 105-108.

Descriptors: *Groundwater management, *Groundwater quality, *Legislation, *Local governments, *Massachusetts, *Water pollution control, *Water pollution prevention, *Wellhead protection, Aquifer management, Groundwater, Groundwater pollution, Groundwater resources, Public participation.

The Town of Easton, Massachusetts, in conjunction with other private and governmental agencies, is actively protecting it groundwater and water supply. The Easton Water Division owns 240 acres surrounding its five pumping stations. The Easton Conservation Commission has been actively acquiring land for many years, currently controlling almost 1400 acres. The State Department of Environmental Management controls a 594 acre state park in Easton, in addition to over 1000 acres in the Hockomock Swamp. In 1973 a Groundwater Protection District Overlay was established protecting the areas immediately adjacent to wells from development. An aquifer protection study was completed in 1987 and new groundwater protection districts and bylaws were proposed and subjected to public review. The new proposals were passed by the Zoning Board in 1988. After years of discussion among the water superintendents of Easton, Norton, and Mansfield the Canoe River Aquifer Advisory Committee (CRAAC) was formed in 1987. The committee has the authority to review all development plans within the aquifer and report its findings to the appropriate agency. In addition, CRAAC has responsibility for keeping citizens informed about issues that affect the quality of their drinking water. To this end several Awareness Days have been held, and the committee has applied for several grants and participated in many state programs aimed at fostering citizen interest, improving the public's knowledge about groundwater issues, and making influencing waste disposal practices, road salting practices, and other activities that affect groundwater. (See also W91-03921) (Tappert-PTT)
W91-03927

BRIDGEPORT HYDRAULIC COMPANY AQUIFER PROTECTION PROGRAM.
Bridgeport Hydraulic Co., CT.
M. L. Johnson.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 111-118.

Descriptors: *Aquifer management, *Connecticut, *Groundwater management, *Groundwater pollution, *Groundwater quality, *Water pollution control, *Water pollution prevention, *Wellhead protection, Groundwater, Groundwater resources, Regional planning.

Bridgeport Hydraulic Company (BHC) is the tenth largest investor-owned water utility in the nation, serving a population of approximately 360,000 in 17 towns in Fairfield, New Haven and Litchfield counties in Connecticut. BHC has always had an active source protection program for both its watershed and aquifer areas. Groundwater pollution threats from hydrocarbons, solvents, and road salt to its wellfields in the mid to late 1980's required BHC to take a more proactive stance in the area of aquifer protection. BHC initiated a three stage aquifer protection program which consists of an aquifer protection plan, aquifer protection workshops, and a public awareness program. The aquifer protection plan included computer modeling of each of the fifteen wellfields, based upon existing information. The models were used to estimate safe yields for each wellfield, as well as defining a critical area of influence. Pollution inventories were then created for the critical zones, and the information was used to locate monitoring wells. The aquifer protection plan also developed emergency response techniques for pollution events, and suggested aquifer protection ordinances. The aquifer protection workshops were developed in conjunction with the Housatonic Valley Association, a conservation group with experience in groundwater protection. Presentations were made to the chief elected officials in the 11 communities with BHC wellfields, informing them of the utilities experience with contamination and stressing preventative actions that can be implemented at the local level. The public awareness program included presenting the workshops to the general public, as well as producing various pamphlets and press releases. BHC's aquifer protection program has already shown great benefits in helping to protect these valuable supplies and developing better relationships with the communities in which these wellfields are located. The program has gained recognition from both federal and state regulatory agencies. (See also W91-03921) (Tappert-PTT)
W91-03928

AQUIFER PROTECTION THROUGH LARGE SCALE COMPUTER MODELLING.
Dufresne-Henry, Inc., Westford, MA.
For primary bibliographic entry see Field 4B.
W91-03929

DETERMINING THE AREA OF CONTRIBUTION TO A WELL FIELD: A CASE STUDY AND METHODOLOGY FOR WELLHEAD PROTECTION.
BCI Geonetics, Inc., Laconia, NH.
W. J. Griswold, and J. J. Donahue.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 123-136. 5 fig, 1 ref.

Descriptors: *Computer models, *Groundwater movement, *Groundwater quality, *Massachusetts, *Model studies, *Path of pollutants, *Water pollution prevention, *Water pollution sources, *Wellhead protection, Alluvial aquifers, Geohydrology, Groundwater, Groundwater management, Groundwater resources.

An hydrogeological evaluation for wellhead protection was conducted in an alluvial valley-fill aquifer in central Massachusetts. The criteria for wellhead protection in Massachusetts are set by the Department of Environmental Quality Engineering (DEQE) and are among the most technically detailed and sophisticated in the nation. DEQE defines its wellhead protection areas as the zone of contribution to a well or wellfield under the most severe pumping conditions that could be reasonably expected, i.e., 180 days of continuous pumping with no areal recharge. A practical, technically defensible, step-by-step method was developed which groundwater professionals can employ to produce a product to address the spirit and letter of the law aimed at wellhead protection. The evaluation begins with the development of an initial conceptual model of the area, evaluating such key

elements as surficial and bedrock geology, associated contributions to groundwater flow, recharge potential, and induced infiltration from streams. The conceptual model is tested and revised through the installation of monitoring wells. Detailed measurements of ambient conditions both of groundwater and surface water flows are taken to isolate the effects of the well(s) from the natural variations in the overall flow regime. The aquifer is then subjected to the stress of a required 120-hour pumping test. The results of analysis of the pumping test and ambient conditions are used in a numerical model to extrapolate from the 120-hour test to the 180-day, no-recharge conditions dictated by DEQE regulations. Finally, the modelled 180-day drawdown results are subtracted from a potentiometric surface map reflecting average non-pumping conditions. The area of contribution is delineated from a flownet constructed on the resultant potentiometric surface. (See also W91-03921) (Author's abstract)
W91-03930

USE OF TIME OF TRAVEL IN ZONE OF CONTRIBUTION DELINEATION AND AQUIFER CONTAMINATION WARNING.
Island Design, New Hartford, CT.
For primary bibliographic entry see Field 5B.
W91-03931

DELINEATION OF CONTRIBUTING AREAS TO PUBLIC SUPPLY WELLS IN STRATIFIED GLACIAL-DRIFT AQUIFERS.
Geological Survey, Marlborough, MA.
P. M. Barlow.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 145-166. 11 fig, 1 tab, 12 ref.

Descriptors: *Computer models, *Glacial aquifers, *Groundwater movement, *Massachusetts, *Model studies, *Water pollution prevention, *Wellhead protection, Groundwater, Groundwater management, Groundwater resources.

Several analytical and numerical methods are available for delineating contributing areas to public supply wells. These methods employ variable levels of computational complexity and require differing levels of data specification. A recent advance in the ability to analyze contributing areas quantitatively has been the coupling of particle-tracking algorithms to numerical groundwater flow models. A demonstration of the use of this method for delineating contributing areas to hypothetical public supply wells pumping from a stratified glacial drift aquifer on Cape Cod, Massachusetts, has shown that (1) the location of a well with respect to areas of recharge and discharge for the aquifer will have a significant effect on the shape of the well's contributing area, (2) the recharge rate to an aquifer and the pumping rate of a well will have a significant effect on the size of the well's contributing area, (3) multiple pumping wells within an aquifer must be considered simultaneously in the determination of a well's contributing area, and (4) the lithology of the aquifer in the vicinity of the well must be well-defined. The study also has shown that contributing areas determined using analytical modeling were similar to those determined using numerical modeling coupled with particle tracking for wells pumping from a thin, single layer, uniform aquifer with simple boundary conditions, and that the use of numerical models for the delineation of contributing areas for wells in such an aquifer may not be warranted. However, numerical modeling and particle tracking provide a better quantitative tool than do analytical models for conditions normally encountered in the field, such as thick, heterogeneous aquifers with complicated boundary conditions in which several wells are pumping simultaneously. Under these conditions, analytical models are not capable of providing sufficient detail to predict accurately the land area which contributes water to a well. (See also W91-03921) (Author's abstract)
W91-03932

DEVELOPMENT OF AQUIFER PROTECTION ZONES AND EVALUATION OF CONTAMINATION POTENTIAL IN TOWN OF CHELMSFORD MUNICIPAL WELLS.
Wehran Engineering Corp., Methuen, MA.
D. W. Podsen, and C. F. Myette.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 167-182. 4 fig, 5 ref.

Descriptors: *Aquifer testing, *Groundwater management, *Groundwater movement, *Groundwater pollution, *Massachusetts, *Water pollution control, *Water pollution prevention, *Water pollution sources, *Wellhead protection, Groundwater, Groundwater resources.

The Town of Chelmsford, Massachusetts, obtains its entire municipal water supply from 22 groundwater wells. Periodic testing since 1979 has detected trace concentrations of volatile organic compounds in nearly all of the municipal well fields, with concentrations in excess of 50 ppb in some wells. As a pilot study for protecting public water supplies in developed towns in Massachusetts, the Department of Environmental Protection (DEP) hired a consultant to evaluate the contamination detected in the town wells. The study focused upon delineating aquifer protection zones, identifying potential past and present contamination sites in these areas, and prioritizing these sites with respect to their potential to impact the town water supply wells. Eighteen of the 22 water supply wells were sampled and the sample analyzed for organic volatile compounds. Results indicated a concentration of 15 ppb in one well, trace concentrations in two other wells, and non-detectable or below detection limit concentrations in the remaining samples. Aquifer protection Zones I, II, and III were delineated for each of the municipal supply wells. A records search was conducted to identify and locate potential sources of contamination that might impact Chelmsford's municipal water supply wells. A total of 121 potential contamination sites were identified and located. An additional 69 sites were identified but could not be located. A ranking system was developed to prioritize sites in terms of their potential to contaminate municipal water supply wells. The system includes such factors as aquifer protection zone designation, distance from a well, types of chemicals, volume of spills, and the ranking of watersheds according to the degree of contamination that has been detected in wells. The ranking system is designed to divide potential sites into groups, with each group assigned a priority ranking relative to one another. It was recommended that preliminary site assessments be conducted for potential sites in the highest priority groups. Fifteen sites have been investigated, and the DEP will conduct a site investigation at the highest priority site. (See also W91-03921) (Author's abstract)
W91-03933

DETERMINING THE DEVELOPMENT POTENTIAL WITHIN WELLHEAD PROTECTION AREAS AND RESULTING IMPACTS FROM NITROGEN LOADING.
Horsley, Witten and Hegemann, Inc., Cambridge, Ma.
S. W. Horsley, C. A. Coughanowr, M. Nelson, and J. D. Witten.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 183-190. 2 fig, 1 tab, 4 ref.

Descriptors: *Groundwater management, *Groundwater pollution, *Massachusetts, *Model studies, *Nitrates, *Nitrogen, *Nonpoint pollution sources, *Water pollution control, *Water pollution prevention, *Water pollution sources, *Wellhead protection, Agricultural runoff, Groundwater, Groundwater resources, Septic tanks, Wastewater.

Groundwater contamination from dispersed, non-point residential and agricultural uses can contaminate public water supplies as effectively as a poorly-sited landfill. A recent case study on Cape Cod, Massachusetts documented a clear correlation between housing densities and nitrate-nitrogen concentrations in groundwater. The methodology for examining the cumulative effects of land development within a wellhead protection area (WHPA) is comprised of two principal steps: (1) determination of the development potential, and (2) prediction of the resulting nitrate-nitrogen concentrations. The total development potential of the WHPA is determined by summing existing development and future potential development. This calculation will result in a quantification of the saturation development, or buildout population. Once the development potential has been determined all potential sources of nitrogen are assessed and tabulated. These sources may include wastewater, residential and agricultural fertilizers, road runoff and precipitation. Several analytical models have been developed to predict nitrate-nitrogen concentrations in groundwater using a mass balance approach. Sources of error include the assumed nitrogen loading and dilution values used in the model. The results of the nitrogen loading assessment are then compared to the drinking water standard for nitrate-nitrogen, currently 10 mg/l as nitrate. Studies indicate it may be necessary to use a lower concentration as a planning guideline in order to achieve the standard 90% of the time. If the programmed development exceeds the assimilative capacity of the water supply a variety of techniques may be used to mitigate for existing development and control future growth to achieve acceptable concentrations. These techniques include regulatory, non-regulatory, and legislative approaches. (See also W91-03921) (Tappert-PTT)
W91-03934

EVALUATION OF LOCAL REGULATORY EFFORTS IN IDENTIFYING AND CONTROLLING THE THREAT OF UNDERGROUND FUEL STORAGE TANKS.
Barnstable County Health and Environmental Dept., MA.
C. Stiefel, and G. Heufelder.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 191-200. 2 fig, 1 tab, 1 ref.

Descriptors: *Legislation, *Massachusetts, *Storage tanks, *Underground storage, *Water pollution control, *Water pollution sources, Groundwater, Groundwater management, Local governments.

For the past two years, the Barnstable County Health and Environmental Department, a regional advisory agency, has coordinated a county-wide effort to assist towns in formulating an overall underground storage tank (UST) management plan for groundwater protection. Certain key elements for initiating a residential UST program have been identified and include passage of a comprehensive regulation, support of regional and local agencies, and public education initiatives. The level of regulation determines the overall reduction of threat to the groundwater, as evidenced by a number of tank removals. When only registration of residential USTs was required, up to 10% of the residential USTs are removed annually. Passage of a comprehensive UST regulation which also includes testing and removal requirements resulted in up to 18% tank removal. Reduction in the number of residential USTs can be greatly enhanced if the local municipality takes initiatives to reduce the removal costs, such as allowing disposal at the local landfill. Administration of an effective UST control program requires a significant time commitment; in Barnstable County this has been supplied at the regional level, with help from local fire and health departments. Regarding commercial USTs, despite comprehensive state regulations, over 20% of the tanks in the study area were not in compliance with testing requirements. Local initiatives in the form of a single notification letter resulted in an almost-immediate reduction of this

figure to 11%. (See also W91-03921) (Author's abstract)
W91-03935

UIC CLASS IV-V WELL SURVEY IN MAINE: INVENTORY, ASSESSMENT AND COMPLIANCE.
Maine Dept. of Educational and Cultural Services, Augusta.
For primary bibliographic entry see Field 5E.
W91-03936

PLANNING TECHNIQUES FOR ESTIMATING GROUNDWATER IMPACTS OF ON-SITE SEPTIC SYSTEMS.
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5B.
W91-03937

EPA/LOCAL PARTNERSHIP AT WORK - THE CREATION OF A GROUND WATER PROTECTION PROGRAM.
Environmental Protection Agency, Philadelphia, PA. Region III.
S. Kerzner.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 257-269. 5 fig.

Descriptors: *Geographic information systems, *Governmental interrelations, *Groundwater management, *Groundwater pollution, *Water pollution control, *Water pollution prevention, *Wellhead protection, Groundwater, Groundwater resources, Local governments.

The Region III Groundwater Protection Section is using Geographic Information System (GIS) technology to work with local water resource agencies to develop and implement county-wide groundwater protection plans. The purpose of working with local agencies is to identify and target for priority regulatory attention those areas that are susceptible to contamination. The GIS technology enabled EPA to provide technical assistance to local agencies in a program with limited federal resources. The GIS case study demonstrated the use of GIS technology in groundwater protection applications and illustrates how the Region and the local officials worked together to develop a mutually beneficial groundwater protection program. Program development, data collection, map coverage construction, composite map construction and evaluation are topics of discussion. Emphasis is placed on the application of GIS, its potential for protecting the underground sources of drinking water, and its impact on management-making decisions. Major project benefits to the local agency and to EPA include creation of a true Federal/local partnership, development of a management tool to assist managers in determining environmental and program priorities, implementation of Wellhead Protection programs at the state and county level, technical assistance for states and local agencies in a program where Federal resources are limited, improved understanding of the scope and nature of environmental problems in the region, and the demonstration of the usefulness of GIS techniques. (See also W91-03921) (Tappert-PTT)
W91-03938

COMPUTERIZED DATA MANAGEMENT SYSTEM FOR WELLFIELD PROTECTION.
Pirnie (Malcolm), Inc., Columbus, OH.
T. F. Jenkins, and G. Jamesson.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 271-286. 10 fig, 5 ref.

Descriptors: *Groundwater management, *Groundwater pollution, *Monitoring, *Municipal water, *Network design, *Ohio, *Water pollution control, *Water pollution prevention, *Wellhead protection, Columbus, Glacial aquifers, Groundwater, Groundwater resources.

The City of Columbus, Ohio operates a municipal wellfield capable of producing approximately 30 million gallons of water per day. Water is withdrawn from a glacial aquifer by four collector wells adjacent to the Scioto River and Big Walnut Creek. The wellfield land is presently subjected to pressures of urban housing, commercial and industrial development, sand and gravel mining, and highways frequented by hazardous material cargoes. The pressures of development and the resulting pollution sources in the area have created potential for wellfield contamination. The City retained a consultant to prepare a 'Wellfield Protection and Management Plan' in July 1988, which proposed creation of a comprehensive groundwater monitoring network covering a two-mile radius around the wellfield. The monitoring network is expected to generate a large amount of data regarding the water quality and flow characteristics of the surface and groundwater. A computerized database management system was developed to effectively manage this data. The system can store and retrieve data, prepare reports, and create graphics. The graphics program can compare the collector well discharge to the water quality parameters over the time span of the data. Having established the background water quality, the database system can readily show any changes in water quality. In addition, the water quality data can be exported to a spreadsheet or other program to develop Piper water quality diagrams or perform other more complex forms of analysis. The database system generates graphic data presentations as information is collected. This allows the City to make quick, reasoned and appropriate decisions regarding wellfield protection. (See also W91-03921) (Tappert-PTT)
W91-03939

MODEL COMMUNITY PROGRAM FOR PRIVATE WELLS.
Connecticut Univ., Storrs. Cooperative Extension System.
R. F. Jeffrey, and K. K. Filchak.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 293-301. 1 fig, 2 tab, 2 ref.

Descriptors: *Connecticut, *Groundwater pollution, *Municipal water, *Water pollution control, *Water pollution prevention, *Wellhead protection, Groundwater, Groundwater management, Groundwater resources, Wastewater.

Successful implementation of a comprehensive municipal groundwater protection program requires knowledgeable consumers. The University of Connecticut Cooperative Extension System's 'model town' program was set up in order to bring individuals into the groundwater protection process. Implemented in 1989, the program provided groundwater information to residents of the rural towns of Brooklyn and Pomfret so that they could properly assist in the management of their private and public groundwater supplies. A variety of delivery systems were used to transfer drinking water supply information to individuals in the two municipalities. A key part of the program was the formation of community advisory groups which included the chief elected official (first selectman), representatives of municipal agencies and organizations, as well as other interested persons. The 'model town' program methodology was designed to supplement Connecticut's aggressive groundwater protection program. The State's effort is targeted at the major aquifers where most municipal and industrial supplies are located, but does not directly address many of the more rural areas where over one-sixth of the population derives its drinking water from individual and smaller community wells. (See also W91-03921) (Author's abstract)
W91-03941

BOARDS OF HEALTH PROTECTION FOR PRIVATE WELLS AND GROUNDWATER.
Massachusetts Association of Health Boards, Plainville.
M. E. Benes.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 303-308.

Descriptors: *Groundwater pollution, *Massachusetts, *Regulations, *Water pollution control, *Water pollution prevention, *Well regulations, Groundwater, Groundwater management.

In Massachusetts, people depending upon private wells are unprotected against improper siting, poor installation, and contamination, except where local health boards have adopted regulations. Effective private well protection depends upon the local board of health adopting a well protection policy which is consistent with local needs and conditions. In addition to specific private well regulations, there are other actions which local boards can take as part of an overall groundwater protection program. These include hazardous waste pickups, underground storage tank regulations, subdivision review, regulation of pesticides and septic tank cleaners, local emergency response planning committees, solid waste disposal regulations, and others. (See also W91-03921) (Tappert-PTT)
W91-03942

PRIVATE WELL PROTECTION IN SAND AND GRAVEL AQUIFERS.
K-V Associates, Inc., Falmouth, MA.
W. B. Kerfoot.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 309-327. 8 fig, 2 tab, 19 ref.

Descriptors: *Glaciohydrology, *Groundwater movement, *Groundwater pollution, *Local governments, *Nitrates, *Nitrogen, *Path of pollutants, *Septic tanks, *Water pollution control, *Water pollution sources, Glacial sediments, Groundwater, Legislation, Massachusetts, Sand, Wastewater.

No state laws exist governing the siting of private wells relative to septic systems. Current state laws concentrating on the siting of septic systems relative to private wells are quite limited. Three municipalities on Cape Cod have enacted public health bylaws specifically to provide for private well protection. The procedure is currently applied to proposed subdivisions and to private lot positioning of well and septic systems in partially built-out subdivisions. The need for private well protection was demonstrated from the results of a survey of private well contamination in the Mares Pond region of Falmouth, MA. The survey found that 29 of 44 wells had elevated indications of contamination. Wells were being affected by plumes of wastewater leachate from on-lot septic systems. The source of contamination was more often the neighbor's system rather than the on-lot system. The special importance of the Mares Pond residential well study was that it demonstrated that the frequency of nitrogen contamination was related to orientation of septic system and well within the groundwater flow field, not just simple distance of separation. The private well protection procedure is devised specifically for unconfined sand and gravel aquifers. Local water table mapping and a small pumping test are combined to obtain information about groundwater flow directions and velocities. Precipitation recharge values are obtained from the USGS Water Resources Division. A sensitivity analysis of velocity, recharge, and anisotropy of hydraulic conductivity values was conducted to evaluate the relative impact on zones of contribution of the private wells. An elliptical approach is strongly recommended over circular distances in regions where groundwater velocities exceed 0.5 ft/day. (See also W91-03921) (Author's abstract)
W91-03943

SAMPLING NETWORK DESIGN FOR TRANSPORT PARAMETER IDENTIFICATION.
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W91-03991

AGRICULTURAL CHEMICAL MANAGEMENT PRACTICES TO REDUCE LOSSES DUE TO DRAINAGE.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
J. L. Baker.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 477-483, 1990. 20 ref.

Descriptors: *Agricultural chemicals, *Agricultural practices, *Agricultural runoff, *Drainage, *Nonpoint pollution sources, *Path of pollutants, *Water pollution control, Crop production, Fertilizers, Hazardous materials, Health advisory, Leaching, Nitrates, Pesticides, Runoff, Soil erosion.

Chemical losses with water and sediment are a product of the mass of carrier and chemical concentration in that carrier. One approach to controlling losses is to utilize chemical management practices that reduce the chemical concentrations in the water and sediment that leave a treated field; another is to control the masses of the carriers. Rate, timing, placement, and choice-of-chemical options are available for the application of fertilizers and pesticides, with varying effects on offsite losses with surface and subsurface drainage. The high water solubility of nitrate-nitrogen that adds to its leachability does not necessarily lead to greater losses with surface runoff water. With continued emphasis on implementation of conservation tillage to control soil erosion, the need exists for improved methods of chemical application that allow incorporation of applied agricultural chemicals with a minimum of crop residue destruction. Funding of sustainable agriculture research programs will add to the gains made by reduced reliance on agricultural chemicals. Research should continue in taking advantage of man-made or natural areal variability in soil factors. Setting of standards or health advisory levels is an important method of maintaining low levels of potentially hazardous compounds. (Brunone-PTT)
W91-04006

AGRICULTURAL CHEMICAL APPLICATION PRACTICES TO REDUCE ENVIRONMENTAL CONTAMINATION.
Illinois Univ., Urbana. Dept. of Agricultural Engineering.
L. E. Bode.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 485-489, 1990. 7 ref.

Descriptors: *Agricultural chemicals, *Agricultural practices, *Application rates, *Environmental protection, *Nonpoint pollution sources, *Water pollution control, Chemical treatment, Education, Fertilizers, Groundwater, Health risks, Pesticide drift, Pesticides, Population exposure, Training.

Current practices of applying agricultural chemicals play a major role in the environmental health concerns of agriculture. Those people who mix, load and handle the concentrated formulations run the greatest risk of exposure but field hands and others can encounter significant levels of pesticides. Drift can be a major source of contamination to residents, wildlife, and water sources. Improved methods of application and ways of reducing the total amount of pesticide applied can help reduce environmental contamination. Chemigation, direct injection, closed system handling, and fertilizer impregnation are types of technology that affect the efficiency of applying agricultural chemicals. Current surveys indicate that point sources such as spills, mixing, and loading areas, back-siphoning, and direct routes for surface water movement into the ground are often a major cause of pesticides reaching groundwater. The commercial dealer/applicator provides storage handling, mixing, and loading for large amounts of chemicals and has received limited guidance regarding the products. Education remains an important element of any rural environmental health strategy. With appropriate information about pesticide risks and groundwater, people will be better equipped to address environmental concerns. Agricultural chemicals pose potential risks to humans, wildlife, water, and the environment in general, because of their biological activity. The magnitude of the risks often depends on the methods and techniques used to apply the chemicals. (Author's abstract)
W91-04007

FOOD PRODUCTION, ENVIRONMENTAL PROTECTION, AND HEALTH EFFECTS IN MEXICAN AGRICULTURE.
Institute for the Development of Occupational Safety and Health, Toluca (Mexico).
For primary bibliographic entry see Field 6G.
W91-04009

SETTING HUMAN-HEALTH-BASED GROUNDWATER PROTECTION STANDARDS WHEN TOXICOLOGICAL DATA ARE INADEQUATE.
Natural Resources Defense Council, Inc., New York.
R. M. Whyatt.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 505-510, 1990. 12 ref.

Descriptors: *Groundwater management, *Public health, *Toxicology, *Water pollution effects, *Water quality standards, Carcinogenicity, Legal aspects, Mutagenicity, Risk assessment, Teratogenic effects.

Toxicological data are not adequate to assess fully the health effects of many of the pesticides that currently contaminate or have the potential to contaminate groundwater. The National Academy of Sciences estimated that in 1984 that data to conduct a complete health hazard assessment exist for only 10% of the pesticides currently on the market. Many pesticides have not been tested for their ability to cause cancer, genetic mutation, or birth defects. There are significant gaps in the toxicological data base for the majority of pesticides for which the Environmental Protection Agency proposed health advisories in 1987. To help assure that groundwater standards are adequately protective of human health when toxicological data are not adequate, additional uncertainty factors can be incorporated into such standards. Alternatively, standards can be set at the level of detection. This approach should be used when no data exist to assess major potential health effects. For example, the detection limit could be the standard if no adequate oncogenicity studies have been conducted. In addition, generic standards may be employed when data are inadequate to set chemical-specific standards. New York State has recently taken this innovative generic standard approach. (Author's abstract)
W91-04010

GAME-THEORETIC PARAMETER CONFIGURATION TECHNIQUE FOR AQUIFER RESTORATION DESIGN.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-04028

INFLUENCE OF PHOSPHORUS ON GROWTH AND NUTRIENT STORAGE BY WATER HYACINTH (EICHHORNIA CRASSIPES (MART.) SOLMS) PLANTS.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5D.
W91-04052

TRANSFORMATION OF CARBON TETRACHLORIDE BY PSEUDOMONAS SP. STRAIN KC UNDER DENITRIFICATION CONDITIONS.
Stanford Univ., CA. Dept. of Environmental Engineering.
C. S. Criddle, J. T. DeWitt, D. Grbic-Galic, and P. L. McCarty.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3240-3246, November 1990. 2 fig, 5 tab, 14 ref. DOE Grant LLNL 458903 and NSF Grant ECE-8519243.

Descriptors: *Bioremediation, *Carbon tetrachloride, *Denitrification, *Fate of pollutants, *Nitrogen fixing bacteria, *Pseudomonas, *Water pollution treatment, Aquifer management, Bacteria, Groundwater treatment, Halogenated compounds, Halogenated hydrocarbons, Path of pollutants.

The use of denitrifying organisms could be advantageous for aquifer bioremediation because, unlike oxygen, nitrate and nitrous oxide are highly soluble in water and easily added. A denitrifying Pseudomonas sp. (strain KC) capable of transforming carbon tetrachloride was isolated from groundwater aquifer solids. Materials used to obtain denitrifying enrichments were obtained from aquifer cores taken at Moffett Field, California, Savannah River, Georgia, and Orange County Water District Well no. 7 in Seal Beach, California. Morphologically distinct colonies were tested for their ability to degrade carbon tetrachloride. Approximately 20 isolates were screened and carbon tetrachloride-degrading isolates were obtained only from the Seal Beach site. This site had no known previous exposure to carbon tetrachloride. Major products of the transformation of 14-C-labeled carbon tetrachloride by Pseudomonas strain KC under denitrification conditions were 14-CO2 and an unidentified water-soluble fraction. Little or no chloroform was produced. Addition of dissolved trace metals, notably, ferrous iron and cobalt, to the growth medium appeared to enhance growth of Pseudomonas strain KC while inhibiting transformation of carbon tetrachloride. It is hypothesized that the transformation of carbon tetrachloride by this organism is associated with the mechanism of trace-metal scavenging. (Mertz-PTT)
W91-04060

IDENTIFICATION AND CATABOLIC ACTIVITY OF WELL-DERIVED GASOLINE-DEGRADING BACTERIA FROM A CONTAMINATED AQUIFER.
Orange County Water District, Fountain Valley, CA. Biotechnology Dept.
For primary bibliographic entry see Field 5B.
W91-04068

BETTER WATER QUALITY INDEXING SYSTEM FOR RIVERS AND STREAMS.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
D. G. Smith.
Water Research WATRAG, Vol. 24, No. 10, p 1237-1244, October 1990. 5 fig, 3 tab, 13 ref, append.

Descriptors: *Classification, *Pollution index, *Water quality, Aquatic life, Environmental quality, Fish, New Zealand, Swimming, Water pollution, Water quality control, Water quality standards, Water supply, Water use.

The development of a better system for indexing water quality and its application to four water use classes was attempted. There are three dominant use classes (bathing, water supply, and fish spawning) and one general use class. In all of the classes, protection of aquatic life is included. In an attempt to convey the information content of water data more simply, one or a few numbers that have been designed to integrate the data pool have been created. Such numbers are called water quality indexes. One purpose in producing them has been to provide the lay-person with easily assimilable information about a water's quality. However, the term quality is often not defined and in many instances the index produced is an attempt to pool several aspects of pollution. To ensure that the index score provides something useful, and does not hide important information, the water quality variable giving the lowest score (for example, the minimum operator) has been employed to produce a final index score. Preliminary indications are that this is a more useful aggregation method than the

more commonly used additive and multiplicative techniques. Index development has been linked to recommended water quality standards developed for New Zealand water legislation. The indexes are intended to assist in the dissemination of water quality information, particularly to lay-people. (Mertz-PTT)
W91-04078

USE OF NON-CONSERVATIVE PARAMETERS TO TRACE WASTEWATER EFFLUENTS IN WATER BODIES.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
For primary bibliographic entry see Field 5E.
W91-04079

IMPORTANCE OF AIR ABSORPTION DURING MECHANICAL INTEGRITY TESTING.
Oklahoma Univ., Norman. School of Petroleum and Geological Engineering.
F. C. Arnold.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2817-2820, November 1990. 4 fig, 1 tab, 5 ref.

Descriptors: *Aquifers, *Geohydrology, *Industrial wastes, *Injection wells, *Pressure testing, *Testing procedures, *Underground waste disposal, *Waste disposal, *Water pollution prevention, Deep well injection, Materials testing, Mechanical failure, Nitrogen, Oxygen, Saline aquifers.

Wells used for the injection of liquid industrial waste into deep saline aquifers are required to be periodically tested for mechanical integrity. A generally accepted method to demonstrate mechanical integrity is to pressurize the casing-tubing annulus and monitor any decline in pressure. If air is used to pressurize the annulus, uncertainty may exist in differentiating between absorption of air into water in the annulus, and loss of pressure due to the absence of mechanical integrity. An analytical model of air absorbance was derived and used to quantify the pressure decline due to dissolving and diffusion of the air in annular water. Because of the low solubility of oxygen and nitrogen gases in water and the slow rate of diffusion of gases through liquids, measurable changes in the pressure of the air blanket due to gas absorption occurred only in very thin air blankets after long periods of time. In a typical annulus pressure test lasting three hours, no measurable change in annulus pressure occurred due to gas absorption. (Mertz-PTT)
W91-04135

MONITORING LINEAR ALKYL BENZENE SULFONATE IN THE ENVIRONMENT: 1973-1986.
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
For primary bibliographic entry see Field 5B.
W91-04143

WATER USE ANALYSIS: ARE WATER QUALITY DATA NEEDED.
Inland Waters Directorate, Ottawa (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 6D.
W91-04173

ECONOMICS OF REDUCING COLORADO SALINITY THROUGH PUBLIC LAND WATERSHED PROJECTS.
Bureau of Land Management, Washington, DC. Soil, Water and Air Branch.
For primary bibliographic entry see Field 6C.
W91-04197

SYSTEM ANALYSIS APPROACH TO WATER RESOURCES MANAGEMENT.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 6A.
W91-04206

PARAMETRIC STUDY OF DIETHYL PHTHALATE BIODEGRADATION.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 5B.
W91-04274

CAN CONTAMINATED, FRACTURED, POROUS AQUIFERS BE RESTORED.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
B. Berkowitz, and D. Ronen.
Naturwissenschaften NATWAY, Vol. 77, No. 9, p 431-433, September 1990. 3 fig, 7 ref.

Descriptors: *Aquifer restoration, *Groundwater pollution, *Remediation, *Water pollution treatment, Flushing, Geologic fractures, Leaky aquifers, Mathematical models, Radioisotopes, Solute transport.

The feasibility of restoring a contaminated, fractured, porous aquifer by flushing with clean water was estimated using a mathematical model. The system studied was composed of a single planar fracture, embedded in a fully saturated porous medium. It was assumed, as a worst case scenario, that the entire system was fully contaminated by either a radioactive or conservative toxic contaminant. A source of clean water was applied at the origin of the fracture. The system was represented by two coupled, one-dimensional equations, one describing transport along the fracture axis and the second describing transport in the porous matrix perpendicular to the fracture axis. For the case of a radioactive contaminant, a sink term accounting for radioactive decay was also present. Solving the for the radioactive contaminant, it was found that flushing over almost 30 y at a relatively high fluid velocity of 0.1 m/d, in a fracture width of 100 micron, would reduce the contaminant concentration within the fracture fluid to 20% of its initial concentration at a distance of 60 m from the fracture origin. The same decrease was obtained at a distance of only 5 m from the fracture origin for the toxic, nonradioactive contaminant. It is concluded that a contaminated, fractured, porous aquifer is not readily flushed. (Author's abstract)
W91-04311

IMPROVED OVERFLOW IN A SEWERAGE SYSTEM AS A POLLUTANT LOAD-REDUCING DEVICE.
BKH Consulting Engineers, The Hague (Netherlands).
H. J. Van Mameren, and J. Zuidervliet.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 181-187, 1990. 6 fig, 2 tab, 4 ref.

Descriptors: *Combined sewer overflows, *Sewer systems, *Storm water management, *Storm-overflow sewers, *Urban runoff, *Water pollution control, Chemical oxygen demand, Conveyance structures, Economic efficiency, Storm runoff, The Netherlands, Urban hydrology, Weirs.

The applicability of improved overflows in sewerage systems in The Netherlands was investigated in a two-phase program. The first phase, an inventory was made of overflow application outside The Netherlands and operation of these structures was studied. In the second phase, fieldwork was conducted to measure the separating efficiencies of one type of improved overflow under conditions prevailing in The Netherlands: namely, flat terrain and multiple connected sewerage systems. As a result of the first part of the investigation, a high-side-weir chamber was built in the municipality of Rotterdam to test this design under field conditions. Between May 1987 and September 1988, 18 storm events were monitored and samples extracted for analyses. The overall efficiency of the high-side-weir chamber was measured to be about 27% for chemical oxygen demand, and 20% for total filtrable residue. Thus it is concluded that improved overflows, such as a high-side-weir chamber, have practical application under conditions as prevail in The Netherlands. This type of structure is a good choice for places where space is limited and finance is a major consideration. (Author's abstract)
W91-04344

POLLUTANT REMOVAL AND EUTROPHICATION IN URBAN RUNOFF DETENTION PONDS.
Aalborg Universitetscenter (Denmark). Environmental Engineering Lab.
C. Toet, T. Hvitved-Jacobsen, and Y. A. Yousef.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 197-204, 1990. 4 fig, 4 tab, 7 ref.

Descriptors: *Detention reservoirs, *Model studies, *Nutrient removal, *Storm water management, *Surface detention, *Urban hydrology, *Urban runoff, *Water pollution control, *Water pollution treatment, Algal growth, Dissolved solids, Eutrophication, Numerical analysis, Particulates, Phytoplankton, Simulation analysis, Storm runoff, Water pollution effects, Water quality management.

A water quality model POND for eutrophication and pollutant removal in urban storm water runoff detention ponds has been developed. The numerical simulation model is a relatively simple, one-dimensional deterministic water quality model consisting of a set of differential equations. Included are processes describing the removal and accumulation of dissolved and particulate constituents as well as processes concerning the yearly cycle of phytoplankton growth and nutrient transformations. The input to the pond is based on runoff quality data and a historical rainfall record. The model has been used to simulate eutrophication and removal of phosphorus and heavy metals in an urban runoff detention pond. In particular, the importance of the pond volume, i.e., the residence time of the runoff water in the pond, for pollutant removal and eutrophication was analyzed. Simulations were carried out based on measured runoff quality data and a 33-year rainfall record. Dry, normal, and wet years and summers were selected for analysis. It was found that, periodically, high algal concentrations in a detention pond can be expected in dry as well as wet summers. In order to obtain pollutant removal efficiencies above 50% for suspended solids, phosphorus, and heavy metals, a detention pond volume larger than 200-300 cu m/ha is recommended. For detention pond volumes between 100 and 300 cu m/ha the main eutrophication variables and processes are almost independent on the pond volume although the yearly mean value may vary due to the rainfall pattern. Therefore, characteristics related to pollutant removal should be superior in the design procedure for those ponds. (Fish-PTT)
W91-04346

REDUCTION OF COMBINED SEWER OVERFLOW POLLUTION LOADS BY DETENTION OF SANITARY SEWAGE.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5D.
W91-04347

APPRAISAL OF CHANGES IN WATERCOURSE QUALITY AS A RESULT OF SEWER RECONSTRUCTION.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5D.
W91-04348

FYLDE COAST BATHING WATER IMPROVEMENTS--STORM WATER MANAGEMENT FOR COMPLIANCE WITH BATHING WATER DIRECTIVE.
North West Water Authority, Warrington (England).
P. C. Head, D. H. Crawshaw, and S. K. Rasaratnam.
Water Science and Technology WSTED4, Vol. 22, No. 10/11, p 223-230, 1990. 2 fig, 2 tab, 3 ref.

Descriptors: *England, *Recreation, *Storm water management, *Swimming, *Urban runoff, *Water

pollution control, *Water quality standards, Beach contamination, Coastal zone management, Design criteria, Discharge measurement, Dispersion, Hydraulic models, Model studies, Sewer hydraulics, Sewer systems, Storm runoff, Time series analysis, Wastewater facilities, Wastewater treatment, Water pollution effects.

As part of the investigations to determine the most appropriate scheme to bring the Fylde Coast (Lancashire, England) bathing waters up to the quality required by the European Communities Bathing Water Directive, mathematical models have been used to examine the hydraulic behavior of the sewerage system and the subsequent dispersion of effluent in the receiving waters. The discharge characteristics of the existing sewerage systems were examined by means of an extensive WASSP (Wallingford Storm Sewer Package) model, and then used in conjunction with a time series rainfall record for the area to investigate the effect of rainfall events on the volume of storm sewage to be discharged. Because the area is drained by a combined system, the management of storm water is of utmost importance and the output of the WASSP model was used to determine the input to the coastal dispersion model for rainfall events. A preliminary examination of the possible sites for sewage treatment works and sea outfalls, for sewage and storm water, suggested four possible schemes involving either inland treatment, marine treatment, or a combination. All options required the discharge of storm water to the sea. Extensive dispersion modeling was carried out to examine the probable effects of various storm water management strategies on bacterial concentrations in the receiving waters, finding that storage of storm flows, with controlled discharge, at the tidal state when impact would be minimal, was required to achieve compliance with the Directive. By integrating the WASSP modeling of various base flow and storm water storage options with dispersion modeling, it was possible to establish appropriate design criteria. (Author's abstract)
W91-04349

SHORT-TERM TOXICITY OF NH3 AND LOW OXYGEN TO BENTHIC MACROINVERTEBRATES OF RUNNING WATERS AND CONCLUSIONS FOR WET WEATHER WATER POLLUTION CONTROL MEASURES.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5C.
W91-04360

APPLICATION OF COMBINED OZONE/HYDROGEN PEROXIDE FOR THE REMOVAL OF AROMATIC COMPOUNDS FROM A GROUNDWATER.
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
J. P. Duguet, C. Anselme, P. Mazounie, and J. Mallevialle.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 3, p 281-294, 1990. 4 fig, 5 tab, 11 ref.

Descriptors: *Aromatic compounds, *Cost analysis, *Groundwater pollution, *Hydrogen peroxide, *Ozonation, *Water pollution treatment, *Water quality management, *Water treatment, Benzenes, Chemical analysis, Fate of pollutants, Filtration, Monitoring, Ozone, Water sampling.

Nitro and chloro-benzene compounds, which are widely used in dye industries, have been associated recently with groundwater contamination. Because of their potential toxicity and for taste and odor considerations, three main actions were undertaken to solve the problem at a French site. First, to follow the advance of pollution toward the wells, samples were collected automatically and analyzed using gas chromatography/mass spectrometry. Results indicate that ortho-chloronitrobenzene was the main pollutant in concentrations ranging from 100 to 2000 micrograms/L. Second, to monitor drinking water quality, an on-line spectrophotometer was used to measure the optical density at 254 nm at the inlet and outlet of the water treatment plant. Third, the feasibility of using the ozone/hydrogen peroxide (O3/H2O2) combination was determined at a 450 L/hour pilot plant. Reduction of concentrations of chloronitrobenzenes from 1900 micrograms/L to less than 20 micrograms/L could be reached by the application of 8 mg O3/L and 3 mg H2O2/L with a 20 minute contact time. To avoid an eventual bacterial regrowth in the network due to biodegradability of the oxidation by-products, sand and GAC filtration were tested after oxidation. An evaluation of the costs of these different treatments for the specific case studied showed that investment and operational costs were of the same order of magnitude as construction costs of new wells at another location and transportation of the water. (Author's abstract)
W91-04382

CHANGES IN FISH MERCURY CONCENTRATIONS IN AN INTENSIVELY FISHED LAKE.
Water and Environment Research Inst., Helsinki (Finland).
For primary bibliographic entry see Field 5B.
W91-04441

RECREATIONAL WATER QUALITY: THE MANAGEMENT OF ENVIRONMENTAL HEALTH RISKS ASSOCIATED WITH SEWAGE DISCHARGES.
For primary bibliographic entry see Field 5E.
W91-04513

ECONOMIC EFFECTS OF LONG-TERM RESTRICTIONS ON DRAINAGE WATER DISPOSAL.
Rhode Island Univ., Kingston. Dept. of Resource Economics.
D. Wichelns, R. Howitt, G. Horner, and D. Nelson.
Applied Agricultural Research AAREEZ, Vol. 5, No. 1, p 48-55, Winter 1990. 5 fig, 5 tab, 7 ref.

Descriptors: *Agricultural engineering, *Crop production, *Drainage practices, *Drainage water, *Economic evaluation, *Wastewater disposal, *Water pollution control, Alfalfa, Arid-zone hydrology, California, Cotton, Crop yield, Grain crops, Leaching, Policy making, Regulations, Root zone, Salt stress, Salt tolerance, Soil contamination, Tomatoes, Water quality, Water table rise, Wheat.

Irrigation of agricultural crops in arid regions often results in the accumulation of salts in the plant root zone, which must be leached through the soil profile in order to reduce their impact on profitability. However, California's water quality authorities are considering restriction of concentrations and loads of salt and selenium from subsurface drainage water released into the San Joaquin River. Policy-makers require information regarding farm-level and regional costs of imposing drainage water disposal restrictions. Crop yield and acreage data from an irrigation district with historical salinity and drainage problems were compared with data from a nonimpacted production region to examine the long-term effects of restrictions on drainage water disposal. Time trend analysis indicates that the production of cotton, tomatoes, alfalfa seed, and grain crops evolved along significantly different paths in the two regions. Results support the hypothesis that salinity and high water tables motivated changes in yields and cropping patterns in the impacted district. Average yields of salt-sensitive and salt-tolerant crops improved in the years following installation of a drainage outlet in the impacted district. Estimated improvements in total revenues, as a result of installing the drainage outlet and improving soil and water conditions, range from $37 per acre for wheat to $698 per acre for tomatoes. (Fish-PTT)
W91-04535

PROBING THE FUTURE OF THE MEDITERRANEAN BASIN.
Mediterranean Blue Plan Regional Activity Centre, Valbonne (France).
M. Batisse.
Environment ENVTAR, Vol. 32, No. 5, p 4-9,28-34, June 1990. 5 fig, 1 tab, 4 ref.

Descriptors: *Future planning, *Marine pollution, *Mediterranean Sea, *Optimum development plans, *Regional development, *Water policy, *Water pollution control, *Water quality, *Water resources management, Albania, Algeria, Cyprus, Economic development, Egypt, Environmental policy, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Model studies, Monaco, Morocco, Spain, Syria, Tunisia, Turkey, Water resources development, Yugoslavia.

Rising concern over the pollution problems of the Mediterranean Sea prompted the Mediterranean coastal countries (Spain, France, Monaco, Italy, Yugoslavia, Greece, Turkey, Syria, Lebanon, Israel, Egypt, Libya, Tunisia, Algeria, Morocco, Malta, Cyprus, and Albania) to adopt unanimously the Mediterranean Action Plan and to sign the Convention for the Protection of the Mediterranean Sea against Pollution in 1976. One of the major components of this plan was a rather unconventional project, named the Blue Plan, to study the various possible futures for the region as a whole, including interactions between populations, resources, the environment, and development. The Mediterranean Sea suffers most from land-based development activities from the last 40 years. The Blue Plan defines three trend scenarios: worse trend, where economic growth remains weak; moderate trend, where better coordination of economic policies among the European Community, the U.S., and eastern Asia contributes to comparatively steady growth; and the reference trend scenario, which assumes the continuation of most current qualitative change. The images of the future provided by the various Blue Plan scenarios do not radically differ up to the year 2000; however, the scenarios for the year 2025 indicate that the situation may change radically and that the state of the environment could deteriorate considerably. It is imperative that policies more vigorous than the current ones be decided on and implemented today if the serious shortages and irreversible degradation threatening the future of the Mediterranean people are to be avoided or mitigated. (Fish-PTT)
W91-04556

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: CONCENTRATIONS OF ARSENIC, CADMIUM, COPPER, LEAD, MERCURY, SELENIUM, AND ZINC IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
C. J. Schmitt, and W. G. Brumbaugh.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 731-747, September/October, 1990. 8 fig, 4 tab, 38 ref, append.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Fish, *Heavy metals, *Monitoring, Arsenic, Biomonitoring, Cadmium, Copper, Lead, Mercury, Selenium, United States, Water pollution control, Water quality, Zinc.

From late 1984 to early 1985, the U.S. Fish and Wildlife Service collected a total of 315 composite samples of whole fish from 109 stations nationwide, which were analyzed for arsenic, cadmium, copper, lead, mercury, selenium, and zinc. Geometric mean, maximum, and 85th percentile concentrations (microg/g wet wt) were as follows: arsenic--0.14, 1.5, 0.27; cadmium--0.03, 0.22, 0.05; copper--0.65, 23.1, 1.0; mercury--0.10, 0.37, 0.17; lead--0.11, 4.88, 0.22; selenium--0.42, 2.30, 0.73; and zinc--21.7, 118.4, 34.2. The mean concentrations of selenium and lead were significantly lower than in the previous National Contaminant Biomonitoring Program (NCBP) collection (1980-81). Mean concentrations of arsenic and cadmium also declined significantly between 1976, when elemental contaminants in fish were first measured in the NCBP, and 1984. Of greatest significance, lead concentrations declined steadily from 1976 to 1984, suggesting that regulatory measures have successfully reduced the influx of lead to the aquatic environment. Mean concentrations of arsenic, cadmium, and selenium also declined from 1976 to 1984, but

not nearly as much as those of lead. The decline was greater, however, than that of the overall mean at some stations where elevated levels were noted in the past. Especially noteworthy were arsenic concentrations in fish from Lake Michigan, which declined by more than 50% from 1976-77 to 1984. (See also W91-04579) (Author's abstract)
W91-04578

NATIONAL CONTAMINANT BIOMONITORING PROGRAM: RESIDUES OF ORGANOCHLORINE CHEMICALS IN U.S. FRESHWATER FISH, 1976-1984.
National Fisheries Contaminant Research Center, Columbia, MO.
C. J. Schmitt, J. L. Zajicek, and P. H. Peterman.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, September/October, p 748-781, 1990. 14 fig, 10 tab, 84 ref, append.

Descriptors: *Bioaccumulation, *Chlorinated hydrocarbons, *Fate of pollutants, *Fish, *Monitoring, *Path of pollutants, *Water pollution control, Benzene, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Polychlorinated biphenyls, Toxaphenes, United States, Water quality.

The U.S. Fish and Wildlife Service periodically determines concentrations of organochlorine chemicals in freshwater fish collected from a nationwide network of stations as part of the National Contaminant Biomonitoring Program (NCBP). From late 1984 to early 1985, a total of 321 composite fish samples were collected from 112 stations and analyzed for organochlorine chemical residues. The mean concentrations of total DDT did not change from 1980-81 to 1984, following a period of steady decline through the 1970's. However, the mean concentrations of p,p'-DDT declined significantly. Residues of polychlorinated biphenyls (PCBs) also remained widespread, but a significant downward trend in total PCBs was evident, and early eluting PCB components were present at fewer stations than in the past. Mean concentrations of dieldrin have not changed since 1978-79; concentrations remained highest in Hawaii and in the Great Lakes. Toxaphene concentrations declined form 1980-81 to 1984, especially in the Great Lakes, and the incidence of toxaphene declined from 88% of the stations sampled in 1980-81 to 69% in 1984. Mean chlordane concentrations did not change from 1980-81 to 1984, following a period of decline. Residues of other organochlorines--mirex, pentachloroanisole (PCA), benzene hexachloride (BHC) isomers, endrin, heptachlor, hexachlorobenzene (HCB), and Dacthal (DCPA)--were either found at relatively low concentrations. In general, organochlorine concentrations were lower in 1984 than at any time reported previously. (See also W91-04598) (Author's abstract)
W91-04579

PRELIMINARY STUDIES ON THE DEVELOPMENT OF A MICROBIOLOGICAL TREATMENT FOR POLYCHLORINATED BIPHENYLS.
BioTreatment Ltd., Cardiff (Wales).
I. Viney, and R. J. F. Bewley.
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 5, p 789-796, September/October, 1990. 5 tab, 27 ref.

Descriptors: *Biodegradation, *Microbial degradation, *Polychlorinated biphenyls, *Soil contamination, *Surfactants, *Waste treatment, *Wastewater treatment, *Water pollution treatment, Aroclors, Culture techniques, Desorption, Laboratory methods, Tensoxid, Triton.

A series of experiments comprising microbiological testing, surfactant screening and microcosm systems were conducted in order to develop a treatment for polychlorinated biphenyls (PCBs). Microbial isolates from contaminated soil and sludge and culture collections were screened for degradation of a defined mixture of PCB congeners in liquid culture. Initially, one group of bacteria substantially degraded the dichloro-to pentachlorobiphenyls except where chlorinated at the 4,4' position, but not hexachlorobiphenyl; whereas other microorganisms, including Phanerochaete chrysosporium, showed greater degradation of the apparently more recalcitrant congeners. Repeated subculturing of the most promising bacteria on biphenyl supplemented media apparently increased their ability to degrade both the range and extent of congeners tested. The non-ionic Triton X-100 and Tensoxid S50 were the most effective surfactants at desorbing PCB from sand but had varying degrees of inhibition either to the growth, or alternatively to the PCB metabolism of the isolates tested. The greatest degree of PCB metabolism in the presence of Triton X-100 was towards 2,3-dichlorobiphenyl, with a general reduction in the degree of degradation of trichlorinated to hexachlorinated congeners. The most effective reduction of Aroclor 1242 in sand systems spiked with 1,000 mg/kg was achieved through a combination of inoculating biphenyl-degrading bacterial isolates together with P. chrysosporium. This resulted in a reduction of approximately 40% in a 20-week period, although this was attributable largely to the removal of the less chlorinated rather than the more chlorinated congeners. (Author's abstract)
W91-04580

RELATIONSHIPS BETWEEN SOME PROPERTIES OF ORGANIC SOILS FROM THE SOUTHERN CANADIAN SHIELD.
Ottawa Univ. (Ontario). Dept. of Biology.
D. A. Brown, S. P. Mathur, A. Brown, and D. J. Kushner.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 363-377, August 1990. 8 fig, 4 tab, 32 ref.

Descriptors: *Bogs, *Canada, *Mine wastes, *Soil types, *Water pollution prevention, Correlation analysis, Methane, Numerical analysis, Organic soils, Peat, Statistical analysis.

Different numerical methods used to distinguish between organic soil types were evaluated to determine if acid leaching from mining wastes could be prevented by capping the tailings with a self-renewing methane-producing muskeg bog that would prevent the penetration of oxygen to the wastes. Thirty organic soils from bogs in the mining districts of Elliot Lake, Sudbury, and Timmins, Ontario, and Noranda, Quebec, were sampled and 28 soil characteristics were measured. These characteristics whose values are normally or lognormally distributed, were analyzed by several different statistical methods. Some characteristics indicate the existence of two populations, and others are bivariantly correlated. Cononical discriminant analysis was more successful than cluster analysis in separating the bogs into well-defined geographical groups. However, principal component analysis proved best at grouping the organic soils according to their organic and inorganic components, and it is suggested that this is a suitable method for the general discrimination of organic soil types. The principal component analysis differentiates the samples mainly by their inorganic contaminants, either water-borne clays from flooding, or aerosol smelter deposition of heavy metals. There were 14 organic and 14 inorganic characteristics, but the inorganic characteristics contribute more to the principal components, possibly because many of these characteristics are correlated. Methane was present in all the 17 bogs tested for it, and in two very wet bogs more than 2 mmol of methane per liter were extracted. (White-Reimer-PTT)
W91-04583

INTERCEPTOR DESIGN AND CONSTRUCTION CONSIDERATIONS AS PART OF THE BOSTON HARBOR CLEANUP.
S E A Consultants, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5D.
W91-04594

EPA'S TECHNICAL SLUDGE REGULATIONS MAY END BENEFICIAL REUSE.
Tennessee Dept. of Health and Environment, Nashville.
R. G. O'Dette.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 30-31, November 1990.

Descriptors: *Environmental policy, *Environmental protection, *Regulations, *Sludge disposal, *Sludge utilization, Copper, Dioxins, Human health, Legal aspects, Model studies, Standards, Wastewater facilities, Zinc.

In February 1989 EPA proposed technical sludge regulations 40 CFR Part 503. These rules will affect every municipality in the U.S. and the majority of industrial indirect dischargers to publicly owned treatment works (POTWs). Recent surveys indicate that industrial users of POTWs have increased and municipal sludge quality has deteriorated. As a result very few POTW sludges can meet the proposed distribution and marketing criteria, especially for copper and zinc. The most serious problem with the National Sewage Sludge Survey (NSSS), that was used to set the criteria, is the quality of the sampling and analyses. In most cases where more than one sludge analysis was reported, the concentrations varied greatly. The problem of representative sludge samples and detection levels are especially critical for dioxin. The detection levels for this type of compound are highly variable because of interference from oil, grease, and other substances. The assumptions used by EPA to develop the technical sludge criteria, using computer models for human risk assessment, may be unreasonable and technically unsound. The 'Peer Review Committee' evaluated EPA's proposed rule and concluded that it was far too restrictive and not representative of good science. (White-Reimer-PTT)
W91-04599

ANNE ARUNDEL COUNTY ACHIEVES WATER-QUALITY EXCELLENCE.
Anne Arundel County Dept. of Utilities, Glen Burnie, MD.
T. H. Neel.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 37-40, November 1990.

Descriptors: *Chesapeake Bay, *Maryland, *Wastewater facilities, *Water pollution control, Anne Arundel County, Costs, Infrastructure, Local governments, Sewer systems, Water quality.

Maryland's Anne Arundel County Department of Utilities was awarded the 'Outstanding Achievement in Water Pollution Control' award as a result of the county's water quality improvements and major capital investment in improving the Chesapeake Bay and its tributaries. The Department of Utilities organizational restructuring has evolved over several years to its current format with a Bureau of Administration and Finance, Bureau of Operations Support Services, and Bureau of Operations, each reporting to the department's director. A comprehensive program of technical training for the Bureau of Operations was instrumental in the turnaround in the performance of existing wastewater treatment plants and the successful startup and efficient control of the new infrastructure resulting from the program. Treatment plants throughout the county were upgraded and rehabilitated in order to improve water quality in the area. Significant capital investment was made to expand collection system infrastructure, and service was extended to many communities with failing septic systems to eliminate health hazards and environmental effects. The total capital budget appropriation for 1983 through 1990 is nearly $209 million. The major improvements to wastewater treatment have allowed Anne Arundel County to produce better than NPDES requirements, and the county is now meeting its responsibility to protect the environment and the quality of life in the Chesapeake Bay region. (White-Reimer-PTT)
W91-04600

PAST PRACTICES AND NEW APPROACHES IN SCUM MANAGEMENT.
M. C. Mulbarger, R. P. Trubiano, T. L. Papes, and G. L. Gallinaro.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 58-64, November 1990.

Descriptors: *Boston Harbor, *Massachusetts, *Scum, *Wastewater treatment, *Water pollution control, Anaerobic digestion, Chemical treatment, Flotables, Incineration, Sampling, Screening.

In late 1985, the Massachusetts Water Resources Authority (MWRA) board ruled that unsightly floatables must be removed from wastewater discharges to Boston Harbor as soon as possible. Project activities initially focused on the magnitude of scum expected at the Deer Island and Nut Island facilities. Of all the waste streams found at a wastewater treatment plant, none is more difficult to obtain a representative sample from than the dilute skimmings removed from a tank. Duplicate results with soluble or colloidal constituents can only be achieved with strict attention to detail. The scum was being co-processed with the other waste solids; however, in recent years scum and sludge grinding has become more popular. This practice minimizes fouling and clumping, theoretically yields more intimate contacting and mixing between substrates and organisms, and eliminates the visual offensiveness of certain biologically inert articles found in the sludge and scum. However, this treatment does not affect grease and scum destruction if the contact time is inadequate. Therefore, treatment alternatives investigated and considered for the two Massachusetts plants included anaerobic digestion, incineration, gravity or dissolved air flotation, sludge screening, and chemical fixation. It was concluded that for the Nut Island facility scum screening would be an easy-to-operate, low-maintenance technology that would control visible floatables and achieve suspended solids removals lower than a gravity-flotation system. Chemical fixation which is typically used to improve the handling and physical characteristics of the waste, decrease the pollution transfer surface area, or limit the solubility of hazardous substances contained in the waste was selected for the Deer Island facility. Chemical fixation technologies change the characteristics of the scum to an acceptable intermediate or final landfill cover. (White-Reimer-PTT)
W91-04602

PRELIMINARY SITE EVALUATION FOR AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE A GUIDE FOR WWTP TECHNICIANS.
Gannett, Fleming, Corddry and Carpenter, Inc., Harrisburg, PA.
For primary bibliographic entry see Field 5E.
W91-04606

SUPERFUND RECORD OF DECISION: PERDIDO GROUNDWATER, AL.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206320. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R04-88/042, September 1988. Final Report. 59p, 14 fig, 4 tab, 2 append.

Descriptors: *Alabama, *Benzenes, *Cleanup operations, *Groundwater pollution, *Perdido Site, *Superfund, *Water pollution sources, *Water pollution treatment, Activated carbon, Adsorption, Aquifers, Costs, Groundwater quality, Monitoring, Reinjection, Site remediation.

The Perdido Groundwater Contamination site is located in the Town of Perdido, Baldwin County, Alabama. Site contamination occurred as a result of a 1965 train derailment on the Louisville and Nashville Railroad (now CSX Transportation, Inc.). Chemicals (particularly benzene) from derailed tank cars spilled into drainage ditches, infiltrating the underlying aquifer. The area of groundwater contamination covers approximately 15 acres and is centered downgradient about 300 yards from the derailment site. The Alabama Department of Public Health, Division of Public Water Supply (ADPWS) first documented reports of taste and odor problems in resident's water wells in 1981. Further studies showed benzene contamination in 6 of 27 wells, which led to supplying bottled water to 250 affected residents. In February 1983 EPA provided immediate removal funding to construct a water supply line to connect to a nearby town. CSXT voluntarily provided funds for and installed the water system in July 1983. The primary contaminant of concern affecting the groundwater is benzene. The selected remedial action for this site includes: groundwater pump and treatment using stripping or activated carbon adsorption with reinjection of treated water back into the aquifer, and air monitoring during operations; and groundwater monitoring to measure success of the cleanup. The estimated capital cost for this remedial action is $169,000 with estimated annual O&M cost of $103,000. (Author's abstract)
W91-04648

WATER QUALITY STANDARDS (JAN 70--MAY 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W91-04651

TRANSFORMATION OF INDOLE BY METHANOGENIC AND SULFATE-REDUCING MICROORGANISMS ISOLATED FROM DIGESTED SLUDGE.
Pennsylvania State Univ., University Park. Lab. of Soil Biochemistry.
R. Shanker, and J. M. Bollag.
Microbial Ecology MCBEBU, Vol. 20, No. 2, p 171-183, 1990. 5 fig, 2 tab, 32 ref. Department of Energy Grant DE-FG02-87 ER60556.

Descriptors: *Anaerobic digestion, *Aromatic compounds, *Biodegradation, *Digested sludge, *In situ treatment, *Mineralization, Fate of pollutants, Methane bacteria, Sludge digestion, Sulfates.

Mineralization of an aromatic N-heterocyclic molecule, indole, by microorganisms present in anaerobically digested sewage sludge was examined in an effort to determine if anaerobic microorganisms may have a potential application in in situ bioremediation processes. The first step in indole mineralization was the formation of a hydroxylated intermediate, oxindole. The rate of transformation of indole to oxindole and its subsequent disappearance was dependent on the concentration of inoculum and indole and the incubation temperature. Methanogenesis appeared to be the dominant process in the mineralization of indole in 10% digested sludge even in the presence of high concentrations of sulfate. Enrichment of the digested sludge with sulfate as an electron acceptor allowed the isolation of a metabolically stable mixed culture of anaerobic bacteria which transformed indole to oxindole and acetate, and ultimately to methane and carbon dioxide. This mixed culture exhibited a predominance of sulfate-reducers over methanogens with more than 75% of the substrate mineralized to carbon dioxide. The investigation demonstrates that indole can be transformed by both methanogenic and sulfate-reducing microbial populations. (Geiger-PTT)
W91-04731

BIOREMEDIATION USING COMPOSTING.
Weston (Roy F.), Inc., West Chester, PA.
R. T. Williams, and C. A. Myler.
Biocycle BCYCDK, Vol. 31, No. 11, p 78-82, November 1990. 1 tab, 1 fig.

Descriptors: *Bioremediation, *Composting, *Explosives, *Hazardous materials, *Military reservations, *Site remediation, *Soil contamination, Compost, Contaminants, Munitions wastes, Sediment contamination, Sludge disposal.

Manufacture and handling of explosives and propellants have caused soil and sediment contamination at U.S. Army munitions facilities. Field demonstrations show that composting is a feasible technology to reduce contaminant levels. The objective of hazardous materials composting is solely to convert hazardous substances into innocuous endproducts. These objectives have several important consequences. For example, operating parameters such as treatment time may need to be modified to ensure acceptable contaminant destruction. In general, the requirements for containment and reduction of hazardous contaminants to acceptable levels require that a more tightly controlled and aggressive approach be employed for composting hazardous substances than for composting wastewater sludges and refuse. Although promising, the limits of composting as a bioremediation method must be kept in mind when evaluating its use. Volatile contaminants may be released during composting requiring additional treatment equipment and increased costs. Microorganisms have yet to be effectively utilized in the treatment of heavy metals. Consequently, a careful evaluation is required when hazardous concentrations of metals or volatile organic compounds are present. Finally, the final fate of the contaminants must be addressed satisfactorily, which is often difficult in light of the complexity of the compost matrix. (Mertz-PTT)
W91-04761

SUPERCRITICAL CO2 -- COSOLVENT EXTRACTION OF CONTAMINATED SOILS AND SEDIMENTS.
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
K. M. Dooley, D. Ghonasgi, F. C. Knopf, and R. P. Gambrell.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 197-203, November 1990. 8 fig, 2 tab, 46 ref. EPA grants R815197 and CR812034-01.

Descriptors: *Carbon dioxide, *DDT, *Polychlorinated biphenyls, *Site remediation, *Soil contamination, *Solvent extraction, *Water pollution treatment, Methanol, Organic matter, Supercritical carbon dioxide, Waste treatment.

A promising technique for the cleanup of contaminated soils is the use of non-toxic supercritical solvents to accomplish extraction. DDT-contaminated (2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane) or PCB-contaminated (polychlorinated biphenyl) topsoils of high organic content were extracted using supercritical CO2 or CO2-5% by weight cosolvent (toluene, acetone, methanol, acetic acid, diethylamine) mixtures at 313 degrees K and pressure of 101 bar. In separate experiments, the pure contaminants were dissolved in supercritical CO2 at the same conditions and the equilibrium solubilities determined. Most of the cosolvents only marginally improve extraction rates over the case of pure CO2. Methanol, however, increases total amounts of DDT removal from 50-80% to >95%, and increases DDT and PCB extraction rates by as much as an order of magnitude. Methanol is a superior cosolvent probably because its hydrogen-bonding ability is better suited to interaction with the organic matter in the soil (humic acids, fulvic acids, polysaccharides); the organic matter essentially dissolves the contaminants in the soil matrix. Comparing a simple-fixed-bed, local equilibrium (based on pure contaminant equilibria) desorption model to the actual desorption data indicates that contaminant solubilities in supercritical fluids are enhanced (over the pure contaminant case) when desorbing from soils. The enhancements may be related to the simultaneous desorption of other low molecular-weight organics from the soils. (Mertz-PTT)
W91-04763

SUPERCRITICAL FLUID EXTRACTION OF AROMATIC CONTAMINANTS FROM A SANDY LOAM SOIL.
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Chemical and Biochemical Engineering.
A. T. Andrews, R. C. Ahlert, and D. S. Kosson.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 204-210, November 1990. 11 fig, 5 tab, 25 ref. EPA agreement no. CR-814055.

Descriptors: *Site remediation, *Soil contamination, *Solvent extraction, *Water pollution treatment, Carbon dioxide, Organic compounds, Supercritical carbon dioxide, Waste treatment.

Options available for cleaning-up soil contaminated by heavy, nonvolatile organic compounds are limited, costly, and often inefficient. Solvent extraction technology, while still largely in the development stage, has been proposed as a viable treat-

ment of oily-type waste materials that are typically incinerated or disposed of on land. For the treatment of soils, the choice of solvent extraction over other techniques will depend on solvent selection, process configuration, process economics, and the levels of residual contaminants/solvents left in the soil. Near-critical fluids and liquefied gases can achieve high efficiencies in the extraction of organic contaminants from soil. Adsorptive behavior of several polycyclic aromatic hydrocarbons from supercritical carbon dioxide onto sandy loam-type soil has been characterized. Data from the solubility of phenanthrene, anthracene, triphenylene, and perylene in supercritical CO2 demonstrates a strong relationship between solubility and the carbon number and angularity of the ring structure. Soil adsorption isotherms for these compounds are non-linear, and have been described using Fruendlich and Brunauer-Emmett-Teller isotherm adsorption models. The slope of the adsorption isotherms has been correlated with polycyclic aromatic hydrocarbons solubility on log-log coordinates. Addition of polar modifiers (for example water or methanol) dramatically reduces the polycyclic aromatic hydrocarbon adsorption levels, indicating the importance of polar adsorption sites on soil surfaces. (Mertz-PTT)
W91-04764

BIOTURBATION: A FACILITATOR OF CONTAMINANT TRANSPORT IN BED SEDIMENT.
Balsam Environmental Consultants, Inc., Salem, NH.
For primary bibliographic entry see Field 5B.
W91-04765

ADSORPTION OF BENZENE FROM AQUEOUS SOLUTIONS BY BENTONITE TREATED WITH QUATERNARY AMINES.
New Mexico State Univ., Las Cruces. Dept. of Civil Engineering.
F. Cadena, R. Garcia, and R. W. Peters.
Environmental Progress ENVPDI, Vol. 9, No. 4, p 245-253, November 1990. 12 fig, 4 tab, 18 ref. U.S. Department of Energy contract W-31-109-ENG-38.

Descriptors: *Bentonite, *Benzene, *Cleanup, *Site remediation, *Water pollution treatment, Adsorption, Clays, Hazardous materials, Hydrocarbons, Organic compounds, Soil contamination, Underground storage.

The rapid growth in reported pollution cases is often due to improper management of chemicals generated by the chemical industry or to spills or releases into the environment. Damage to groundwaters by leaking underground storage tanks is a common problem. Underground storage tanks are often used to store gasoline or other petrochemical or petroleum-based products, and the EPA estimates that 35% of the existing underground storage tanks either leak or are not liquid-tight. The adsorptive properties of Wyoming bentonite, which has been tailored using various tetraalkylammonium ions, have been investigated for the selective removal of hazardous organic pollutants found in waters and soils contaminated by petrochemical spills. The effectiveness of the tailoring agents is evaluated by comparing the adsorption isotherms of benzene on both treated and untreated soils. Five tetraalkylammonium-type compounds were investigated: ammonium, tetramethylammonium, tetraethylammonium, tetrapropylammonium, and tetrabutylammonium. The adsorption capacity of the treated clay decreases for doses that exceed the optimum dose because of the increase in organic content in solution, which induces a reduction in the partition coefficient between organically coated solid and the liquid phase. Despite the similarity in nature of the tetraalkylammonium cations, significant differences in the adsorption capacities were obtained for the various compounds. Comparing the results with other research indicated that the linear adsorption coefficient decreased as the alkyl chain length increased and that the adsorption capacity likewise decreased. The branched-chain tailoring agents result in more of a crowding effect of the interlamellar space than that off the straight-chain, single-branched tailoring agents, resulting in less adsorption of benzene onto the clay by the branched-chain tailoring agents. (Mertz-PTT)
W91-04770

CONTAMINATION OF SOIL WITH OILFIELD BRINE AND RECLAMATION WITH CALCIUM CHLORIDE.
Agricultural Research Service, Mandan, ND. Northern Great Plains Research Center.
S. D. Merrill, K. L. Lang, and E. C. Doll.
Soil Science SOSCAK, Vol. 150, No. 1, p 469-475, 1990. 2 fig, 3 tab, 15 ref.

Descriptors: *Brines, *Decontamination, *Groundwater pollution, *Oil pollution, *Soil contamination, Calcium chloride, Cation exchange, Dispersion, Leaching, Soil types.

Contamination of soils with oilfield brines is a significant environmental problem in many oil production areas. A soil column technique was used to study details of the brine contamination process and subsequent reclamation of contaminated soil with calcium chloride. Cherry silt loam (fine-silty, mixed, frigid typic Ustochrepts) was contaminated with brine of 0.9 mole fraction sodium chloride in total electrolyte concentration of 3000 mol/cubic m under conditions approximating steady-state miscible displacement. Dispersion of observed sodium breakthrough contamination was only marginally greater than that of chlorine. The isotherm for calcium exchange by sodium is ordinarily unfavorable with large associated exchange-dispersion in miscible displacement. However, the strength of brine used here was high enough to render exchange quasifavorable. Calculations under a simple exchange-chromatographic model indicated that sodium flux in these conditions would be subject to a relatively small level of exchange-dispersion. Sufficient calcium was applied (0.24 mol/cubic m calcium chloride in 0.2 L) to replace exchangeable sodium (ES) in the uppermost 16 cm of brine-contaminated columns (inside diameter, 12.7 cm), which were then leached with either distilled water (DW) or synthesized saline groundwater (SW; SAR = 5.9, electrolyte = 53 mol/cubic m). Leaching was continued until soil dispersion occurred, with 0.54 and 0.68 pore volumes, respectively, of DW and SW infiltrated. Reclamation was demonstrated to be very efficient, with an 89% and 92% removal of ES through the upper 16 cm soil depth being accomplished by DW and SW, respectively. (Author's abstract)
W91-04799

PASSIVE TREATMENT TECHNOLOGY CLEANS UP COLORADO MINING WASTE.
Camp, Dresser and McKee, Inc., Denver, CO.
S. Morea, R. Olsen, and T. Wildeman.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 6, 9, December 1990.

Descriptors: *Acid mine drainage, *Artificial wetlands, *Cleanup operations, *Colorado, *Water pollution prevention, *Water pollution treatment, Acid streams, Copper, Heavy metals, Hydrogen ion concentration, Iron, Lead, Mine drainage, Pilot plants, Zinc.

The artifacts of prospecting in Colorado--tunnels, shafts, and slag piles--have been abandoned, and hazardous metals are being released through acidic mine drainage, threatening aquatic life and posing health risks to human populations. In 1985, a remedial investigation and feasibility study was conducted at five abandoned tunnels that discharged heavy metal loads into Clear Creek, 35 miles west of Denver, Colorado. The study evaluated the full range of potential treatment technologies, from conventional treatment using active-lime precipitation to plugging mines. It was concluded that a natural or passive treatment technology offered the only economically feasible alternative. Passive treatment involves a range of abatement techniques that rely on artificial wetlands to promote natural geochemical mechanisms (neutralization, reduction, adsorption, and precipitation) to raise the pH of mine drainage and remove metals. A pilot-scale passive treatment module was built at the portal of an abandoned mining tunnel. The module was designed to treat 15% of the acidic mine drainage flowing from the tunnel. The design consisted of a reinforced concrete trough with treatment cells. Each cell contained a layer of river rock, a layer of compost material or substrate, and rushes and cattails transplanted from nearby. During 3 years of operation, various configurations, substrate materials, hydraulic loading rates, and microbiological parameters were tested at the pilot plant. At optimum conditions, passive treatment removed up to 98% of the zinc in the mine drainage, 99% of the copper, 94% of the lead, and 86% of the iron. It also increased pH from 3.0 to a value greater than 6.5. Based on the pilot plant's success, EPA and the Colorado Department of Health have contracted for construction of full-scale passive treatment plants to treat drainage from 5 tunnels near Idaho Springs and Central City, Colorado. (Mertz-PTT)
W91-04813

TURKEY CONFRONTS POLLUTION OF IZMIR BAY.
Black and Veatch, Kansas City, MO.
M. J. Graham, and W. D. Skinner.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 20-22, December 1990. 1 fig.

Descriptors: *Combined wastewater, *Izmir Bay, *Municipal wastewater, *Turkey, *Wastewater facilities, *Wastewater treatment, *Water pollution control, Biological oxygen demand, Lagoons, Sludge drying, Suspended solids, Wastewater lagoons, Wastewater management, Water quality, World Bank.

After years of neglect, the city of Izmir, Turkey, is cleaning up Izmir Bay. Assisted by a $184 million loan from the World Bank, the Izmir Water and Sewerage Authority has begun a construction program to intercept and treat the combined wastewater of about 1.7 million people. This wastewater currently flows untreated into the bay. The city's wastewater improvement project includes a 70-km interceptor. Six pump stations will be necessary to lift the wastewater along the way. The World Bank stipulates that a lagoon treatment system be used. The treatment plant has been designed to produce an effluent that contains a filtered biological oxygen demand concentration less than 50 mg/L and a suspended solids concentration less than or equal to 150 mg/L. Treatment facilities consist of bar screens, a grit removal system, and lagoons. Wastewater from the maturation ponds will be discharged into the Gedez River, which forms the west boundary of the treatment plant site and discharges to the Middle Bay. Initially, no disinfection will be provided. Water quality in Izmir Bay will be monitored to determine the need for microoganism reduction. Sludge that accumulates in the lagoons will be periodically pumped to drying lagoons by floating dredges. Dried sludge will be used as a soil supplement or disposed of in landfills. (Mertz-PTT)
W91-04814

ENVIRONMENTAL PROTECTION IN EASTERN EUROPE.
Institute for Soil Fertility, Haren (Netherlands). Dept. of Soil Physics and Root Ecology.
S. Kabala.
Water Environment & Technology WAETEJ, Vol. 2, No. 12, p 42-44, December 1990. 6 tab.

Descriptors: *Eastern Europe, *Environmental policy, *Environmental quality, *Information exchange, *Water pollution control, *Water pollution prevention, Air pollution, Bulgaria, Czechoslovakia, Environmental impact, Environmental protection, Forests, Information transfer, Metals, Public policy, Water pollution.

Since 1989, environmental affairs have taken on the role of training ground for democracy in Eastern Europe. These issues were a motivator of political change in a arena where people could not participate in public political activity in a broad context. Today, this has changed as enviromentalism is only one of many areas now open for public and political attention in a completely different political context across the region. According to statistics gathered by Bulgaria's International

Union for Conservation of Nature, one-third of the forests in Eastern Europe are damaged by air pollution; the Black Sea is being polluted by industrial waste, sewage, and oil; and metals pollution is contaminating and destroying farmland. In Czechoslovakia, 70% of the rivers are heavily polluted and 40% of the wastewater is untreated. Across the region, losses due to environmental deterioration and natural resource waste are between 10-15% of the gross national product. There is a need for the development of institutional structures to make the transfer of technology work to improve the ability of Eastern Europe to find solutions to its environmental problems. Envisioned is technical assistance from the U.S. The technology transfer goal is to develop a response to needs identified by partner institutions and counterpart professionals that will enable Eastern Europe to tap resources that do exist--scientific, managerial, and economic resources--and tap information resources in the U.S. in order to address the environmental problems that exist in Eastern Europe. (Mertz-PTT)
W91-04817

LESSONS LEARNED FROM COMPACTED CLAY LINER.
McClelland Engineers, Inc., Houston, TX.
B. R. Elsbury, D. E. Daniel, G. A. Sraders, and D. C. Anderson.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 11, p 1641-1660, 1990. 9 fig, 3 tab, 20 ref. EPA, Risk Reduction Engineering Lab contract 68-03-3250.

Descriptors: *Clay liners, *Impoundments, *Landfill linings, *Landfills, *Liners, *Water pollution prevention, Bonding, Compaction, Permeability.

Compacted clays have long been used as liners for landfills and impoundments to serve as barriers to the flow of water. A highly plastic clay liner was compacted in the field with full-sized equipment to an average of more than 100% of standard Proctor maximum dry density. The average field permeabilities of two sections of the liner, as measured with four sealed double-ring infiltrometers and a 16 x 16 ft pan lysimeter, were .00003 and .00010 cm/s. Laboratory permeability tests were conducted on samples compacted in the laboratory by three procedures, only one of which gave a reasonable prediction of the permeability of the liner. The two most important factors that led to the failure to destroy the soil clods and to bond the lifts were: (1) using a relatively light roller; and (2) compacting the soil at a moisture content dry of the lowest moisture content at which the roller can remold the clods. Another factor that probably contributed to the high permeability of the clay was the 1 ft thickness of the liner. The low overburden pressure from the thin liner allowed swelling of the clay, which possibly enlarged the interclod macropores. Also, having only two lifts increased the opportunity for hydraulic defects in successive lifts to interconnect. The basic objectives (destruction of soil clods and bonding between lifts) and 17 other key factors that influence the permeability of compacted clays explain the performance of the liner and provide a basis for understanding how to construct liners to avoid such high permeabilities. (Author's abstract)
W91-04839

INDIANA WATER QUALITY, 1988, MONITOR STATION RECORDS, RIVERS AND STREAMS.
Indiana Dept. of Environmental Management, Indianapolis. Office of Water Management.
For primary bibliographic entry see Field 5B.
W91-04857

1990 FARM BILL: OPPORTUNITIES FOR GROUNDWATER PROTECTION.
Environmental and Energy Study Inst., Washington, DC.
J. Campbell Bird, and J. Edmond.
Environmental and Energy Study Institute Policy Report, July 9, 1990. 29p, append.

Descriptors: *Environmental protection, *Farm Bill, *Groundwater quality, *Legislation, *Water pollution prevention, *Water quality control, Agriculture, Farm management, Information exchange, Research priorities.

Half of the nation's population draws its drinking water from groundwater supplies. As much as 95% of those who live in rural areas depend on groundwater for drinking. Some individuals and groups, including some agricultural chemical manufacturers and dealers, researchers, farmers and government officials, believe that the most important source of agricultural chemical contamination of groundwater is from 'point' sources, such as leaks and spills. Over the past 3 years, the Environmental and Energy Study Institute (EESI) has conducted an extensive examination of the relationships among federal farm policies, agricultural chemical use and groundwater contamination. EESI recommends the adoption of 'integrated farm management' systems that, first, minimize all chemical applications and, second, employ only the safest chemicals when chemicals must be used. After carefully weighing the issues and assessing the information and points of view gathered during the examination of groundwater problems, EESI has formulated the following recommendations for congressional action on the 1990 farm bill: (1) Base flexibility--farmers need the ability to plant a variety of crops on a sufficient number of acres in order to minimize chemical inputs and still maintain profits; (2) Incentives for integrated farm management--proposals in the conservation titles of the House and Senate Agriculture Committees' bills create voluntary, multi-year programs for farmers who develop and implement integrated farm management plans; (3) Research--currently, federally supported agricultural research focuses on input-intensive agricultural production systems. Unlike the House farm bill proposal, the Senate proposal incorporates research on integrated farm management systems into current research goals. EESI recommends that Congress adopt the Senate proposal for the overall goals of agricultural research; and (4) Information and technical assistance. (Lantz-PTT)
W91-04859

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

GROUND WATER RESOURCE BASED MAPPING, NASHUA REGIONAL PLANNING AREA, NEW HAMPSHIRE.
Environmental Protection Agency, Boston, MA. Region I.
D. Delaney.
IN: Protecting Ground Water from the Bottom Up: Local Responses to Wellhead Protection. Proceedings of the Conference, October 2-3, 1989, Danvers, Massachusetts. Underground Injection Practices Council, Oklahoma City, Oklahoma. 1989. p 287-291. 1 fig.

Descriptors: *Geographic information systems, *Mapping, *New Hampshire, *Wellhead protection, Databases, Groundwater, Groundwater management, Groundwater resources.

The United States Environmental Protection Agency (EPA) Region I is working to improve groundwater resource protection by continuing to develop and use Geographic Information Systems (GIS). GIS can facilitate the use of environmental resource data to support Federal and state environmental program decisions and work products. The Nashua Regional Planning Area in New Hampshire was selected as a pilot mapping area because GIS-compatible digital US Geological Survey maps with hydrogeologic information were available. The purpose of the mapping initiative is to depict groundwater resources in the pilot study area and to show the geographic relationships between these resources and potential contamination sources. Goals of the program are to support EPA and state capability to identify environmental problems and assess their nature and significance, support state development and implementation of wellhead protection programs, promote interagency program coordination of resource protection efforts, and demonstrate use of resource mapping to support prioritization of EPA program activities. The Groundwater Protection Bureau of the New Hampshire Department of Environmental Services is actively inventorying injection wells, solid waste dumps, contaminant releases, wastewater discharges, and underground storage tanks within the study area. The state agency has access to the University of New Hampshire GIS that provides them with the capability to use GIS products. The GIS databases developed allow identification and delineation of important Nashua area water resources and facilitate evaluation of impact of potential contaminant sources near water supply sources. The information displayed through GIS can improve the ability to focus regulatory activity to protect critical resources. (See also W91-03921) (Tappert-PTT)
W91-03940

GOAL-PROGRAMMING TECHNIQUES FOR OPTIMAL RESERVOIR OPERATIONS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
G. V. Lognathan, and D. Bhattacharya.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 820-838, November/December 1990. 1 fig, 4 tab, 25 ref.

Descriptors: *Goal programming, *Reservoir operation, *Water resource management, Cost analysis, Decision making, Forecasting, Linear programming, Precipitation.

The problem of optimal reservoir operations consists of obtaining optimal releases, reservoir storages, and downstream reach routed flows based on forecasted inflows and precipitation. Five goal-programming schemes that minimize deviations from a set of preferred target storage and flow values are considered: (1) Preemptive goal programming; (2) weighted goal programming; (3) min-max goal programming; (4) fuzzy goal programming; and (5) interval goal programming. The reservoir operation problem is also formulated as a multiobjective linear program (MOLP). MOLP formulation has the following advantages: No penalty function is required that avoids subjective estimates; no priorities are imposed on objectives and therefore meaningful tradeoffs can be considered; allowances in targets can be permitted as in other goal programs; only efficient points are generated whereas min-max and fuzzy goal programs can select inefficient points if alternate optima are not examined; and, the decision maker is provided with noninferior alternatives for consideration that other single-objective optimization models lack. The only disadvantage is that the method can generate a large number of efficient points and may require implementation of some single-objective optimization schemes for selection of a subset of efficient points. (Brunone-PTT)
W91-03994

WATER-USE DATA FOR WATER RESOURCES MANAGEMENT.
For primary bibliographic entry see Field 6D.
W91-04161

CANADA'S NATIONAL WATER-USE ANALYSIS PROGRAM.
Inland Waters Directorate, Ottawa (Ontario).
For primary bibliographic entry see Field 6D.
W91-04162

MEASURING THE PUBLIC'S PERCEPTION OF WATER RESOURCES USING THE CONTINGENT VALUATION METHOD.
New Hampshire Dept. of Resources and Economic Development, Concord.
S. D. Shultz, and B. E. Lindsay.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 159-169, 26 ref.

Descriptors: *Data acquisition, *Economic aspects, *Public opinion, *Public participation, *Water resources management, *Water use data, Decision making, Environmental protection, Groundwater resources, Surveys, Water supply.

Collecting information on the public's actions, attitudes and perceptions of water resources has become an integral part of the decision making process of many water resource projects and policies. Several methodologies have been developed to generate this type of information. One particular technique, contingent valuation, is now regularly being used to measure the monetary values that people are willing to pay for water resources. The basic theories and necessary fundamentals of the contingent valuation method (CVM) are reviewed, and the potential advantages and limitations of applying CVM's to water resource issues are illustrated by highlighting an active CVM experiment to determine New Hampshire households' willingness to pay (WTP) for groundwater protection. The New Hampshire CVM project has three stated goals: (1) to determine the dollar value which individual Dover, NH households are willing to pay for groundwater protection; (2) to determine the extent to which several variables and socio-economic characteristics influence WTP for groundwater protection; and (3) to evaluate the use and effectiveness of both personal and mail interviews in contingent valuation studies. (See also W91-04161) (Lantz-PTT)
W91-04179

KNOWLEDGE-BASED SYSTEMS FOR WATER RESOURCES MANAGEMENT.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 6D.
W91-04184

COLOR-GRAPHICS BASED WATER DEMAND FORECASTING MODEL.
Utah State Univ., Logan. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W91-04187

RELATIONAL DATABASE FOR NON-PROGRAMMERS.
Salt River Project, Phoenix, AZ. Data Base Div.
For primary bibliographic entry see Field 7C.
W91-04188

WATER SUPPLY MANAGEMENT AND PLANNING IN THE STATE OF CONNECTICUT.
Whitman and Howard, Inc., Wellesley, MA.
K. C. Klein.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 317-326, 2 fig, 6 ref.

Descriptors: *Connecticut, *Planning, *Water resources management, *Water supply, *Water use data, Competing use, Management planning, Washington, Water demand, Water use.

Conflicting demands for water resources have become critical in the urban corridor of the State of Connecticut. An increasing population, varying land uses, and a large number of individual water utilities combine to create water supply management challenges. The State of Connecticut is addressing the issue of water supply management through implementation of a comprehensive coordinated water resource planning process. The primary purpose of this study is the coordinated planning process and the data gathering methodologies utilized by the participants. The type of planning program being implemented in Connecticut is based on principles used in a similar program conducted in Washington state. Connecticut has tailored the program to fit its particular situation, and currently is 2 years into the process. The residents and water suppliers of Connecticut stand to benefit from this ongoing effort to better manage the state's water resources. This planning process is intended to guide the actions of individual, regional and state officials in making water resource decisions. The wise management of water resources will ensure the success of continuing economic and individual development within the state. (See also W91-04161) (Author's abstract)
W91-04196

WATER DISTRIBUTION SYSTEMS ANALYSIS: SPECIFIC CONSIDERATIONS.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
For primary bibliographic entry see Field 6D.
W91-04199

WELL FIELD MANAGEMENT FOR OPERATIONAL EFFICIENCY.
Texas Tech Univ., Lubbock.
For primary bibliographic entry see Field 4B.
W91-04200

SYSTEM ANALYSIS APPROACH TO WATER RESOURCES MANAGEMENT.
Weston (Roy F.), Inc., West Chester, PA.
J. Y. Yang.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 415-424, 1 fig, 2 ref.

Descriptors: *Systems analysis, *Water quality, *Water resources management, *Water reuse, *Water use data, Water demand, Water supply, Water treatment, Water use.

Consideration in water resources management should include both water supply and water quality along with the economic constraints. System analysis techniques provide a useful tool for the quantification and predictive analysis for areas where demands for good quality water are growing. Applications of operations research techniques have been developed for defining and evaluating alternative designs for water reclamation and reuse systems that meet a variety of water quality and quantity requirements of industrial and municipal users. To determine the feasibility of a water reclamation and reuse system, the water quantity and quality requirements for each potential use must be estimated. The degree of treatment required of a renovation process will be determined by the specific intended reuse. These water quality requirements can differ greatly from one use to another. Yet, quantity constraints can be satisfied if the amount of wastewater available for reclamation can be reclaimed economically and demands met. The sensitivity of the least cost solution to variable demands for industrial water, the variation of biochemical oxygen demand, concentrations in influent to a wastewater treatment plant, and the variable nature of effluent standards for the receiving stream are all factors which need to be addressed. (See also W91-04161) (Author's abstract)
W91-04206

USE OF DEPARTURE ANALYSIS IN DECISION MAKING.
National Park Service, Fort Collins, CO. Water Resources Div.
For primary bibliographic entry see Field 4C.
W91-04209

DROUGHT DURATION AND FREQUENCY IN THE NORTH-CENTRAL GREAT BASIN, 1600-1982, AND IMPLICATIONS FOR WATER SUPPLY.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-04212

USE OF BASE-FLOW DATA TO MANAGE WATER USE DURING A DROUGHT.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-04213

VIRGIN RIVER: PLANNING FOR DEVELOPMENT WHILE MEETING FLOW REQUIREMENTS FOR ENDANGERED SPECIES.
Utah Dept. of Natural Resources, Salt Lake City. Div. of Water Resources.
For primary bibliographic entry see Field 6D.
W91-04217

CONSERVING WATER RESOURCES THROUGH INTEGRATED POWERPLANT WATER MANAGEMENT.
San Juan Generating Station, Waterflow, NM.
For primary bibliographic entry see Field 3E.
W91-04222

PLANNING FOR USE OF UNCONVENTIONAL WATER SOURCES.
Electric Power Research Inst., Palo Alto, CA. Planning and Evaluation Div.
For primary bibliographic entry see Field 3E.
W91-04223

CONSUMPTIVE USE ESTIMATES IN REGIONAL POLICY RESEARCH.
Economic Research Service, Washington, DC. Soil and Water Branch.
For primary bibliographic entry see Field 6D.
W91-04228

WATERSHED MODELING FOR WATER RESOURCES MANAGEMENT.
Weston (Roy F.), Inc., West Chester, PA.
J. Y. Yang.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 723-732, 2 fig, 5 ref.

Descriptors: *Model studies, *Planning, *Water resources development, *Water resources management, *Water use, *Water use data, *Watersheds, Competing use, Data interpretation, Forecasting, Groundwater, Hydrologic budget, Land use, Oklahoma, Simulation analysis, Streamflow.

A watershed simulation model was developed for water resources management in northwestern Oklahoma based on conservative practices and water use data. The model is a physically-based simulation model designed to evaluate the causes of decreasing stream flow in the study area and to estimate future watershed yields under the impacts of man's activities. These activities include: groundwater pumping, streamflow diversion, stock pond development, and land management activities such as conservation measures. The model can be calibrated against different watersheds with various climatic and hydrological conditions and watershed characteristics. From daily rainfall, the model calculates direct runoff, infiltration, soil water content, river channel loss, streamflow depletion by pumping, pumping from groundwater storage, and total watershed outflow. Estimates of monthly, annual, and long-term average annual watershed yields were demonstrated for the North Canadian River basin. (See also W91-04161) (Author's abstract)
W91-04237

PHOENIX WATER RESOURCE PLAN--1987.
Phoenix City Water and Wastewater Dept., AZ.
P. Regli.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 815-824, 1 fig, 5 tab, 1 ref.

Descriptors: *Management planning, *Phoenix, *Water demand, *Water resources management, *Water supply development, *Water use data, *Water yield improvement, Arizona, Drought effects, Water conservation, Water supply.

The Phoenix Water Resource Plan (PWRP) is the official water resource plan for the City of Phoenix, Arizona. It covers the area of supply, demand management, and supply augmentation. The plan

also addresses the issue of drought management. In severe drought, the implementation of the water conservation plan, along with the development of additional resources, is essential to meet forecasted demand for water. Without a combination of new supplies and demand management, the City of Phoenix cannot meet the demand for water and will be unable to deal with a severe drought during the next century. It is crucial to examine both water conservation and demand augmentation to determine which strategies best benefit a municipality. (See also W91-04161) (Lantz-PTT)
W91-04245

DO THE RIGHT THING.
K. M. Strzepek, and S. C. Chapra.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 11, p 55-56, November 1990.

Descriptors: *Computer programs, *Decision making, *Environmental policy, *Expert systems, *Water resources management, Advanced Decision Support Systems, Bureau of Reclamation, CADSWES, California, Colorado River, Geographic information systems, QUEST, Runoff, Santa Ana.

At the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES), engineers and scientists are developing software to support water resources and environmental decision making. These advanced decision support systems (ADSS) bring high-resolution graphics, artificial intelligence, and geographic information systems (GIS) together on a common hardware platform, the engineering workstation. Two systems designed by CADSWES already are having an impact on governmental planning and management. At the Santa Ana Watershed Project Authority (SAWPA) in California, the CADSWES developed the QUEST (Quality Evaluation System) ADSS. The system links QUAL2E, EPA's principal stream water quality model, with pre-processors and post-processors. The QUEST ADSS already has an impact on the planning process at SAWPA. Analysts can quickly examine many alternatives, permitting them to develop a more comprehensive grasp of the impact of their decisions. CADSWES is developing a multifaceted ADSS to automate the Bureau of Reclamation's 24-month study of Colorado River tributary runoff on engineering workstations. To be completed in the mid-1990s, this system will include an intelligent user interface for the existing 24-month model, an expert system based on the knowledge of the current master engineers, and direct software links between the river model and forecasting systems. Initial testing indicates that substantial time savings are being realized. (Rochester-PTT)
W91-04409

REMARKS ON THE APPLICATION OF A RISK-AVERSE APPROACH TO THE MANAGEMENT OF 'EL CARRIZAL' RESERVOIR.
Brescia Univ. (Italy). Dipt. di Automazione Industriale.
R. Soncini-Sessa, J. Zuleta, and C. Piccardi.
Advances in Water Resources AWREDI, Vol. 13, No. 2, p 76-84, 1990. 4 fig, 8 ref.

Descriptors: *Argentina, *Management planning, *Mathematical models, *Model studies, *Multipurpose reservoirs, *Operating policies, *Planning, *Reservoir operation, *Reservoirs, Irrigation water, Reservoir releases, Reservoir storage, Risk-averse approach, Water management, Water supply.

A risk-averse approach for deriving management policies for a multi-purpose water reservoir, that was first applied to the 'El Carrizal' (Argentina) reservoir, was developed. The method guarantees a satisfactory system performance even for extreme hydrological events. The main feature is its avoidance of stochastic uncertainty descriptions that affect future inflows. Instead, the resulting operating policies minimize the worst failure of the system in response to any inflow series obtained by concatenating in any order the one-year-long inflow sequences of a given 'reference set.' These sequences are considered to be representative of the most critical conditions for the system. The application to the 'El Carrizal' reservoir showed that the choice of the 'extreme events' to be included in the 'reference set' (i.e. the insertion in this set of extreme sequences with very low probability of occurrence) may produce a significant decrease of the future performances; a fact that is typical of any risk-averse approach. Another feature of these operating policies is that they suggest, in general, a whole set of releases instead of a single value. The releases of this set are all equivalent from the point of view of the satisfaction of the objectives. This introduces some flexibility that may be used by the manager to accommodate secondary objectives not considered in the formulation of the problem. (Author's abstract)
W91-04827

DECISION SUPPORT FOR BEST MANAGEMENT PRACTICE SELECTION.
Purdue Univ., Lafayette, IN. Water Resources Research Center.
B. A. Engel.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-111500/AS. Price codes: A03 in paper copy, A03 in microfiche. Technical Report No. 188, June 1990. 11p, 19 ref. USGS Contract No. 14-08-0001-G1561. USGS Project No. G1561-02.

Descriptors: *Computers, *Decision models, *Erosion control, *Expert systems, *Soil erosion, Agriculture, Conservation, Hydrologic models, Land use, Mathematical models, Rainfall-runoff models, Sedimentation, Systems analysis, Water quality, Watershed management.

Excessive soil erosion is a concern in many areas of the United States and throughout the world. Determining the severity of erosion at a site and the appropriate management practices to reduce the problem requires expertise. A knowledge system (expert system) to determine the severity of erosion due to water and to suggest best management practices (BMPs) to alleviate erosion problems at a site was developed. A hypertext program to provide additional information concerning BMPs was developed to be used with the BMP selection knowledge system or to be used as a stand alone information system. (USGS)
W91-04905

6B. Evaluation Process

WATER DISTRIBUTION IN EL PASO--MODELING A COMPLEX SYSTEM.
Camp, Dresser and McKee, Inc., Dallas, TX.
For primary bibliographic entry see Field 5F.
W91-04114

SOCIALLY OPTIMAL AND MARKET UTILIZATION OF GROUND-WATER RESOURCES.
National Ecology Center, Fort Collins, CO.
For primary bibliographic entry see Field 4B.
W91-04191

WATER TRANSFERS IN ARIZONA: ASSESSING THE ADVERSE EFFECTS ON AREAS OF ORIGIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 6D.
W91-04219

RELIABILITY IN MARKET TRANSFERS OF MUNICIPAL WATER SUPPLIES.
Colorado Coll., Colorado Springs. Dept. of Economics and Business.
For primary bibliographic entry see Field 6D.
W91-04220

WATER RESOURCES AND THE ELECTRIC POWER INDUSTRY: AN AUSTRALIAN PERSPECTIVE.
For primary bibliographic entry see Field 3E.
W91-04224

FRAMEWORK FOR RESHAPING WATER MANAGEMENT.
Florida Univ., Gainesville. Coll. of Engineering.
W. Viessman.
Environment ENVTAR, Vol. 32, No. 4, p 10-15,33-35, May 1990. 32 ref.

Descriptors: *Management planning, *Nonstructural alternatives, *Regulations, *Water management, *Water policy, *Water resources management, Environmental policy, Institutional constraints, Natural resources, Policy making, Political aspects, Resources management, United States, Water quality, Water resources.

The United States has been a leader in designing and applying state-of-the-art methods to identify, understand, and deal with an array of water management issues; however, new, more sophisticated strategies must be employed to meet the challenges of the future. During the last 40 years, there have been many attempts to reshape U.S. water policy. Today, water management policies no longer focus solely on development, but favor nonstructural measures. Issues which remain for which new water management policies are urgently needed include: burgeoning populations; poverty; daily deaths of children from water-borne diseases; destruction of forests, wetlands, and croplands; depletion of natural resources; injurious land management practices; solid waste disposal; acid precipitation effects; contaminated drinking water; ocean disposal; offshore development; nonpoint-source pollution; and natural disasters. Furthermore, an array of institutional elements that impede the design and implementation of water policies must be dealt with, such as obsolete laws and regulations, water allocation policies that breed wastefulness, subsidies that encourage inefficient operations, lack of funds, and incompetence. The U.S. needs a better informed and educated public; modernized institutions; adequate resources; improved planning and forecasting capabilities; unified land and water management policies; improved understanding and handling of risk; and the right forums for problem-solving. If the people elect informed, dedicated leaders, demand responsible and timely action, and work at overcoming parochialism, there is hope that sufficient good water can be made widely available. (Fish-PTT)
W91-04555

PROBING THE FUTURE OF THE MEDITERRANEAN BASIN.
Mediterranean Blue Plan Regional Activity Centre, Valbonne (France).
For primary bibliographic entry see Field 5G.
W91-04556

NATURAL RESOURCE ACCOUNTING SYSTEMS AND ENVIRONMENTAL POLICY MODELING.
New Mexico State Univ., Las Cruces. Dept. of Economics.
R. Cabe, and S. R. Johnson.
Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 5, p 533-539, September/October 1990. 1 fig, 4 tab, 12 ref.

Descriptors: *Accounting, *Environmental policy, *Land management, *Model studies, *Natural resources, *Resources management, Agriculture, Appraisals, Conservation, Economic evaluation, Gross national product, Nonstructural alternatives.

The idea implicit in the phrase 'natural resource accounting systems' is to combine national income and product accounting (NIPA) concepts with the analysis of natural resource and environmental issues, either by applying NIPA concepts to the analysis of public policy questions involving nonmarket environmental goods or exhaustible natural resources, or by including magnitudes related to these aspects of economic activity in national income aggregates. Both approaches are applicable to the natural resource appraisal conducted by the U.S. Department of Agriculture (USDA) under the Soil and Water Resources Conservation Act of 1977 (RCA), directing the Secretary of Agriculture to periodically collect, analyze, and report

data in a way that amounts to natural resources accounting, or appraisal, for the agriculture sector. The second (most recent) RCA appraisal touched on a number of economic effects--such as land use, onsite effects of erosion and runoff, salinization, degradation of rangeland, availability of irrigation water, flood damage, ozone and acid deposition, groundwater pollution, wildlife habitat, and wetland preservation--but did not attempt to place a dollar measure on a majority of the analysis elements. A new framework has been developed with additions to extend the accounts to incorporate effects treated in the second RCA appraisal. Three important distinctions are necessary to accomplish the extension: (1) the distinction between effects on assets and effects on current flows; (2) the distinction of effects that enter the cost functions of businesses from effects that impinge directly on household welfare; and (3) the two-way classification of nonmarket effects according to sector of origin (agricultural or other) and sector of impact. (Fish-PTT)
W91-04563

ECONOMIC TOOL FOR REUSE PLANNING.
Milliken Chapman Research Group, Inc., Littleton, CO.
For primary bibliographic entry see Field 5D.
W91-04823

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

COMMODITY PRICES, DEMAND CHARGES, IMPACT FEES AND WATER SERVICES.
Georgia Univ., Athens. Inst. of Natural Resources.
J. Sellers, and R. M. North.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 143-150, 47 ref.

Descriptors: *Pricing, *Water demand, *Water resources management, *Water use, *Water use data, Economic aspects, Financing, Infrastructure, Literature review, User charges, Water resources development, Water supply.

Water pricing and infrastructure funding have changed in scope, source and effect since the early 1960s. Little attention has been given to public water pricing structures that were designed to: (1) generate predetermined amounts of revenue; (2) limit subdivision development; (3) limit water use; and (4) provide profits for public vendors. Studies suggest that many public water suppliers engage in pricing to provide market rates of returns on capital. Over the last decade, public water systems have adopted capital budgeting approaches that lead to requirements for developer financing of growth in water services, and of impact fees for developing a new supply infrastructure. These new pricing structures produce very different results in terms of traditional economic theories of efficient pricing, efficient resource allocation, and economic equity. (See also W91-04161) (Lantz-PTT)
W91-04177

PRICE AND INCOME ELASTICITIES IN THE ANALYSIS OF WATER DEMANDS FOR THE CITY OF HAYS, KANSAS.
Missouri Univ.-Rolla. Dept. of Economics.
R. Bryant, and S. M. Tillman.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 151-158, 2 tab, 10 ref.

Descriptors: *Economic aspects, *Financing, *Municipal water, *Water demand, *Water use, *Water use data, Consumptive use, Hay, Kansas, Model studies, Pricing, Water supply.

The City of Hays, is located in the west central region of Kansas along Big Creek in the center of Ellis County, Kansas. An examination of the effects of price and income elasticities on the demand for water in Hays, was necessary to meet the increasing population of the city. Elasticity is defined as the percent change in the dependent variable divided by the percent change in the independent variable on water demand. Several models were developed which would provide information on income and price elasticities expressing the relative effects of these variables on the quantity of water demanded. The variables chosen were derived from the literature, and include: median family income, price of water, annual rainfall and temperatures, size of family, residents per housing unit, and population. The data for the model consisted of time series data collected from the period 1951-1985. Based on the developed models, it is apparent from the income elasticities, that as income increases, water demand will increase. For example, one of the models presented indicates that a 1% change increase in income will lead to an increase of 0.76% in water consumption. (See also W91-04161) (Lantz-PTT)
W91-04178

MEASURING THE PUBLIC'S PERCEPTION OF WATER RESOURCES USING THE CONTINGENT VALUATION METHOD.
New Hampshire Dept. of Resources and Economic Development, Concord.
For primary bibliographic entry see Field 6A.
W91-04179

EFFECTS OF A PUMPING TAX ON GROUND WATER DEMAND BY IRRIGATORS.
Economic Research Service, Washington, DC. Soil and Water Branch.
C. W. Ogg, N. R. Gollehon, and D. H. Negri.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 171-177, 2 tab.

Descriptors: *Groundwater irrigation, *Groundwater resources, *New Mexico, *Pumping, *Taxes, *Water conservation, *Water demand, *Water use data, Groundwater management, Irrigation, Irrigation practices, Nebraska, User fees, Water use.

State policies for conserving groundwater for irrigation generally employ permits for quotas rather than pumping taxes. There has been some uncertainty about the reduction in water use forthcoming from the imposition of a tax. Present water demand analysis using water use and pumping cost data from 1,927 farms sampled by the Farm and Ranch Irrigation Survey, found only modest water savings per acre from the imposition of a pumping tax. This lack of responsiveness held true for both Nebraska, a state that only partially depends on irrigation, and for New Mexico, where farmers depend more heavily on irrigation. The lack of water conservation can be partly attributed to the relative unresponsiveness of adoption of water saving technologies, such as sprinkler irrigation, to the cost of water. (See also W91-04161) (Author's abstract)
W91-04180

COSTS OF WASTEWATER USE IN THE TUCSON BASIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
A. L. Lieuwen.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 307-316, 1 fig, 3 tab, 11 ref.

Descriptors: *Costs, *Tucson Basin, *Wastewater utilization, *Water conservation, *Water reuse, *Water use data, Cost-benefit analysis, Economic aspects, Groundwater resources, Public policy, Water quality, Water resources management, Water supply, Water use.

In the Tucson Basin of Southern Arizona, wastewater use is critical for successful compliance with the 1980 Arizona Groundwater Management Act, which mandates the gradual decrease and eventual elimination of groundwater overdraft. In accordance with Tucson's wastewater use policies, the municipal water utility plans to serve an increasing number of golf courses and other nonresidential water users with tertiary-treated wastewater (reclaimed water). Evaluation of the cost of Tucson's reclaimed water system indicates that it will be difficult for the utility to persuade self-supplied groundwater users to switch to reclaimed water if the utility prices this water according to cost of service. Comparisons of the current (1987) cost of providing reclaimed water with the current cost of pumping local groundwater indicates most self-supplied groundwater users have no economic incentive to switch to reclaimed water. Policies and institutions that shape Tucson's present approach to wastewater use preclude more flexible, and perhaps more economically efficient approaches to conserving potable groundwater by matching water quality with the quality needs of the intended use. (See also W91-04161) (Author's abstract)
W91-04195

ECONOMICS OF REDUCING COLORADO SALINITY THROUGH PUBLIC LAND WATERSHED PROJECTS.
Bureau of Land Management, Washington, DC. Soil, Water and Air Branch.
D. Waite, and D. Muller.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 327-335, 1 fig, 16 ref.

Descriptors: *Colorado River Basin, *Economic aspects, *Public lands, *Salinity, *Water quality management, *Water use data, Cost-benefit analysis, Resources management.

Land administered by the Bureau of Land Management (BLM) comprises about 40% of the total area of the Colorado River basin. Runoff from these lands contributes a significant amount of salt to the Colorado River system, and thus, reduce its usefulness for municipal, agricultural, and industrial purposes. Federal funds to control salt from public lands, as well as the many other public and private point and nonpoint sources, are becoming increasingly limited. Salinity control projects present special data collection and analysis challenges for the BLM because of the immense size and diversity of public land watersheds. Not only is it a challenge to evaluate and quantify the amount of surface runoff and sedimentation, and to develop relationships that show the amount of salt these mechanisms transport 'without' these projects, but the effects 'with' the project must also be quantified. Holistic watershed planning and economic analyses, as discussed in this paper, are the key to establishing the proper funding for, and management of, public rangelands in reducing Colorado River salinity. (See also W91-04161) (Lantz-PTT)
W91-04197

ROLE OF GOVERNMENT AGENCIES IN THE FINANCING OF WATER SUPPLY SYSTEMS.
Minnesota Univ., Duluth.
For primary bibliographic entry see Field 6E.
W91-04207

ECONOMICS OF METER TESTING/CALIBRATION.
Moore and Kling, Inc., Northborough, MA.
A. A. Betteridge.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 1, p 35-42, March 1990.

Descriptors: *Cost analysis, *Economic evaluation, *Hydraulic equipment, *Maintenance costs, *Water metering, Calibrations, Testing procedures, Water conveyance, Water management.

The economics of a water utility can be practically described as the fiscal management of operational and capital expenditures with reference to the source(s) of revenue to meet those expenditure and the development (and conservation) of its natural resource, water. Since the water meter is a primary accounting source in every water utility, a meter testing and repair program is important. An analy-

sis is made of factors involving the economics of a meter testing program and economics of a meter repair/replacement program. Quantifiable costs and benefits of a testing program include cost-to-implement figures such as utility or company conducted programs and projected revenue increase analysis. In the case of a repair/replacement program, important aspects include meter evaluation criteria, costing-the-job (repair and replacement), and comparison of repair and replacement costs. Illustrations of case after case of financial benefits that far outweigh the cost of appropriate repair can be demonstrated. However, it is essential to arrive at a decision to repair or replace a meter through careful analysis of each situation. (VerNooy-PTT)
W91-04372

REGIONAL COOPERATION IN THE USE OF IRRIGATION WATER: EFFICIENCY AND INCOME DISTRIBUTION.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
D. Yaron, and A. Ratner.
Agricultural Economics, Vol. 4, No. 1, p 45-58, April 1990. 1 fig, 2 tab, 14 ref, 2 append.

Descriptors: *Cooperatives, *Economic aspects, *Income distribution, *Irrigation, *Regional development, *Water use, Agriculture, Cost pricing, Mathematical models, Salinity, Side payments.

An analysis of the economic potential of regional cooperation in water use in irrigation under conditions characterized by a general trend of increasing salinity. Exchange of water quotas and water mobility among farms was assumed. Income maximizing solutions for the region are derived and the related income distribution schemes are solved for, with the aid of cooperative game theory algorithms and shadow cost pricing. Distinction is made between distribution policies with and without side payments, and the application of the alternative models to a quasi-empirical case shows that the regional income can be increased by 17% by means of cooperation with side payments. However, several difficulties are involved in the adoption of policies with side payments: general resentment of farmers to adopt side payments as a policy; all schemes of allocation of the cooperation gains among the farms lead to unsound results. Payments for transfers of water according to a shadow cost pricing scheme also lead to apparently unacceptable results because water is subsidized and rationed, with its shadow price being considerably higher than the price paid by the farmers and farmers may benefit from the rent derived from water quotas, unless it is used for production. The Nash-Harsanyi approach seems to be the most appropriate for the conditions studied. (Brunone-PTT)
W91-04436

RISK-EFFICIENT IRRIGATION STRATEGIES FOR WHEAT.
Western Australia Univ., Nedlands. Inst. of Agriculture.
For primary bibliographic entry see Field 3F.
W91-04437

IMPACT OF INFORMATION ON ENVIRONMENTAL COMMODITY VALUATION DECISIONS.
Georgia Univ., Athens. Dept. of Agricultural Economics.
J. C. Bergstrom, J. R. Stoll, and A. Randall.
American Journal of Agricultural Economics AJAEBA, Vol. 72, No. 3, p 614-621, August 1990. 1 tab, 23 ref, append.

Descriptors: *Economic aspects, *Environmental impact, *Environmental policy, *Information, *Model studies, Mathematical models, Resource management, Wetlands.

Information may be an important determinant of perceived values that consumers place upon environmental commodities. A conceptual model is developed which provides insight into how information affects willingness to pay for environmental commodities. A refutable hypothesis of the effects of a specific information (SI) type on the magnitude of willingness to pay for an environmental commodity is tested. The hypothesis is tested using a contingent valuation method experiment. The theoretical model was applied to develop a testable hypothesis concerning the effect of SI on the magnitude of willingness to pay (WTP) for wetlands protection. This hypothesis was tested using a contingent valuation field survey experiment. Results indicate that information affects willingness to pay in a theoretically plausible manner. The results indicate that SI increased WTP for wetlands protection. This information effect is argued not to be an undesirable bias. SI increased the completeness and accuracy of wetlands protection valuations and therefore induced a desirable information effect. The results support the contention that information is important for accurate environmental commodity consumer valuations. The results may not generalize to situations where additional SI may also describe consumption services of attributes that consumers value negatively. A more complete understanding of the effects of specific types of information on consumer valuation requires additional research. (Brunone-PTT)
W91-04438

EVALUATION OF A SUBSURFACE 'POP-UP' SPRINKLER.
Max C. Fleischmann Coll. of Agriculture, Reno, NV.
For primary bibliographic entry see Field 3F.
W91-04536

6D. Water Demand

REDUCING WATER DEMAND DURING DROUGHT YEARS.
East Bay Municipal Utility District, Oakland, CA.
For primary bibliographic entry see Field 3D.
W91-03971

CONSERVATION IN ARABIAN GULF COUNTRIES.
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
A. A. Akkad.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 5, p 40-50, May 1990, 3 fig, 17 tab, 34 ref.

Descriptors: *Developing countries, *Persian Gulf, *Water conservation, *Water demand, *Water resources development, *Water resources management, *Water use efficiency, Desalination, Domestic water, Groundwater mining, Irrigation design, Public participation, Social aspects, Wastewater renovation, Water distribution, Water loss.

In the Persian Gulf countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, demand for water has increased dramatically as a result of rapid development, an improved standard of living, and diversification of economic activity. Countries such as Saudi Arabia, Kuwait, Qatar, and Bahrain are using nonrenewable subsurface water resources in large quantities, causing groundwater depletion and deterioration in groundwater quality. Although a significant amount of renewable groundwater and surface runoff is available in Oman, the United Arab Emirates, and Saudi Arabia, these resources still need to be properly developed in an integrated context. To meet the growing demand for water, other alternatives such as wastewater reclamation and desalination are being developed. Important means of conserving agricultural water resources include covers, linings, and automation systems to reduce seepage and evaporation losses during conveyance and in the fields. Substantial reduction in agricultural water demand can also be achieved by developing means to reduce transpiration losses, such as (1) breeding plant varieties that transpire less, (2) reducing air movement by using windbreaks, and (3) applying chemicals. Residential conservation can by accomplished through numerous administrative and technical means, for example: (1) water auditing and leak detection; (2) encouragement of public awareness of the scarcity and importance of water; (3) physical means such as replacing inefficient toilets, washing machines, and shower heads; and (4) economic incentives to those who conserve and enforcement of penalties against those who waste the resources. A shift in societal values from a development-oriented to a conservation-oriented view of water resources is occurring. Conservation of natural resources in general, and water resources in particular, is a principal component of Islamic teaching; the most important and effective way to make the public aware of conservation from an Islamic perspective is through the media and the educational system. (Doyle-PTT)
W91-03973

WATER-USE DATA FOR WATER RESOURCES MANAGEMENT.
Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. 830p. Edited by Marvin Waterstone and R. John Burt.

Descriptors: *Water resources data, *Water resources management, *Water use, *Water use data, Conferences, Data acquisition, Data storage and retrieval, Databases, Legal aspects, Remote sensing, Simulation analysis, Surveys, Symposium, Water management.

During the past decade, Federal involvement in water supply development has been sharply curtailed. The efficient and equitable distribution of good quality water at a reasonable cost is a demanding task even under favorable conditions, and it is a difficult challenge where water supplies are not abundant, where populations have grown rapidly, or where various water use interests compete for diminishing supplies. In order to meet this challenge, water managers must have accurate, timely data on water supply, demand, and quality. However, not only is this information sometimes difficult to obtain, but the databases are constantly expanding and changing. Water managers must have the means to interpret and apply these data. The main purpose of this symposium was to provide an opportunity for professionals engaged in the many and varied aspects of water resources to share their experience and knowledge regarding water use data for water resources management. Papers were presented from a variety of disciplines and institutions, from diverse locations, and from divergent perspectives. Included in the list of those presenting papers are hydrologists, economists, lawyers, water managers, biologists, and other professionals from about 40 states and four foreign countries. The many session titles reflect the breadth of the symposium. In addition to about 60 presentations in a poster session, the symposium includes an oral program of about 90 papers on water use data (both national and state surveys), supply and demand management, water conservation, institutional, economic and legal issues in water management, remote sensing applications, database management, water use simulation, and agricultural and drought management issues. (See W91-04162 thru W91-04245) (Lantz-PTT)
W91-04161

CANADA'S NATIONAL WATER-USE ANALYSIS PROGRAM.
Inland Waters Directorate, Ottawa (Ontario).
D. M. Tate.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 1-9, 3 fig, 15 ref.

Descriptors: *Canada, *Project planning, *Water management, *Water use, *Water use data, Data acquisition, Databases, Forecasting, Model studies, Public policy, User fees, Water demand, Water resources management, Water supply.

The development of Environment Canada's National Water-Use Analysis Program is outlined. Canada's approach to water management has traditionally focused on the manipulation of an abundant water supply to meet perceived needs. These needs have been viewed as requirements rather than demands that can be influenced by policy.

Most data collection, research and policy attention had been concerned with supply, followed by water quality. With the onset of regional water shortages, several international management problems and restrictions on the availability of development capital, water use has come to be viewed as the third most important aspect of water management. Water use interprets and integrates trends and conditions in water supply and quality. Data gathering, research, water pricing, modeling, and water demand forecasting are examined as part of a water use analysis program. One hallmark of the Canadian program is its focus on developing the functional aspects of the data, concurrently with the database itself, as opposed to setting up a program that focuses on data collection. The database aspect of the program is still under development. (See also W91-04161) (Lantz-PTT)
W91-04162

COORDINATION OF FEDERAL WATER-USE-DATA COLLECTION AND DISSEMINATION.
Geological Survey, Reston, VA.
D. B. Manigold, and S. J. Wentz.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 15-20, 3 tab, 8 ref.

Descriptors: *Data acquisition, *Data storage and retrieval, *Federal jurisdiction, *Water use, *Water use data, Decision making, Handbooks, Information exchange, Interagency cooperation.

Federal agencies need accurate water use information to conduct their planning, policy making, scientific, and regulatory missions. In June 1984, a Federal interagency subcommittee was formed to coordinate water use data collection activities and to prepare recommended methods for acquiring water use data. The subcommittee includes representatives from the Departments of Agriculture, Commerce, Defense, Housing and Urban Development, and Interior; Tennessee Valley Authority; EPA; International Boundary and Water Commission, US Section; Federal Emergency Regulatory Commission; and the International Joint Commission. During the last four years, member agencies have exchanged information on their water use activities for offstream and instream purposes. An outline for the recommended methods, which addresses needs expressed by the member agencies has been prepared and some draft text has been completed. The subcommittee plans to publish the first phase of their recommendations in 1989 as Chapter 11 of the National Handbook of Recommended Methods for Water-Data Acquisition. (See also W91-04161) (Author's abstract)
W91-04163

CASE STUDY IN SURVEY DEVELOPMENT: 1988 FARM AND RANCH IRRIGATION SURVEY.
Bureau of the Census, Washington, DC.
D. I. Peterson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 21-29.

Descriptors: *Agriculture, *Case studies, *Irrigation practices, *Surveys, *Water resources management, *Water use data, Data acquisition, Data storage and retrieval, Error analysis, Irrigation programs.

The 1988 Farm and Ranch Irrigation Survey is being conducted to supplement basic irrigation data that were collected from all farm operators in the 1987 Census of Agriculture. The survey will enumerate a sample of irrigators to provide detailed data relating to on-farm irrigation practices without burdening all of the farm operators. This is the third survey devoted entirely to the collection of on-farm irrigation data for the contiguous US. Procedures and steps used in the design of the survey instrument for collecting data from the various farm operators who irrigate their acreage. Focus is placed on topics such as: user input, questionnaire content and design, development of an adequate sampling panel, methods and procedures for identifying and correcting respondent errors, methods of editing and input, and relations to other sets of data. (See also W91-04161) (Lantz-PTT)
W91-04164

TRENDS IN WATER USE IN THE UNITED STATES, 1950 TO 1985.
Geological Survey, Reston, VA.
W. B. Solley, and R. R. Pierce.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 31-39, 6 fig, 7 ref.

Descriptors: *Groundwater use, *United States, *Water use, *Water use data, Competing use, Hydroelectric power, Industrial water, Irrigation, Municipal water, Water demand, Water management, Water supply.

Water use estimates compiled by the US Geological Survey (USGS) at 5 year intervals indicate that total freshwater and saline water withdrawals in the US in 1985 were 399,000 mgd, a rate more than double that estimated for 1950 and 10% less than that estimated for 1980. Water use (self-supplied withdrawals and public supply deliveries) increased from 1950-80; however, 37 states indicated less water use during 1985 than during 1980. For most water use categories, the rate of increase in estimated water use declined from 1970 to 1975, and from 1975 to 1980. Withdrawals for thermoelectric power generation and irrigation, the two largest water use categories, were 13% and 6% respectively, and less during 1985 than during 1980. The combined total for industrial, commercial, and mining water use during 1985 was 25% less than during 1980--the lowest combined estimate for these categories since 1950. (See also W91-04161) (Author's abstract)
W91-04165

WATER SUPPLY AND USE IN THE UNITED STATES--U.S. GEOLOGICAL SURVEY NATIONAL WATER SUMMARY 1987.
Geological Survey, Reston, VA.
R. W. Paulson, E. B. Chase, and J. E. Carr.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 41-49, 5 fig, 7 ref.

Descriptors: *Surveys, *Water demand, *Water supply, *Water use, *Water use data, Databases, Water management, Water resources management, Water sources.

Water use estimates have been compiled by the US Geological Survey (USGS) for more than 30 years. These data provide a source of hydrologic information for a myriad of planning and operational purposes at local, State, regional, and river basin levels throughout the Nation. In the aggregate, these data and other hydrologic data provide a basis for assessing national hydrologic conditions. 'National Water Summary 1987--Hydrological Events and Water Supply and Use' is one of a series of USGS publications that, in a State by State format, assess the nation's water resources. The summaries provide a synopsis of the current water year conditions and focus on different hydrologic themes each year. Reports published before the 1987 volume summarize the Nation's water issues, groundwater quality and surface water quality. The 1987 summary assesses water supply and use; each state summary contains descriptions of the history of development of water resources in the State, summarizes the source, use, and disposition of water, and mechanisms in the State for managing water use. (See also W91-04161) (Author's abstract)
W91-04166

WATER-USE REGISTRATION AND REPORTING IN INDIANA.
Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.
J. J. Hebenstreit.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 51-55, 1 tab.

Descriptors: *Data acquisition, *Indiana, *Water use, *Water use data, *Water use regulations, Data storage and retrieval, Databases, Groundwater use, Water metering.

In 1983, the Indiana General Assembly enacted Indiana Code 13-2-6.1 which mandated the Indiana Department of Natural Resources to conduct an inventory of significant users of water. The statute provides that the owners of all wells or surface intakes which have the capability of withdrawing 100,000 gal of groundwater/d or surface water/d must register with the Department of Natural Resources. Registration of facilities was begun in mid-1984, and since that time, approximately 2,600 facilities consisting of 4000 wells and 1000 surface intakes, have been registered. The department has now collected water use data for 1985 and 1986, and a summary of 1986 water use data has been published. Metering of withdrawals is not required, and a number of estimating techniques (such as time of operation times pump capacity) are considered acceptable for reporting purposes. The water use database will be used in conjunction with an ongoing statewide program to assist the Department of Natural Resources to plan for the development, conservation, and utilization of the State's water resource. (See also W91-04161) (Author's abstract)
W91-04167

WATER USE REPORTING IN KANSAS.
Kansas State Board of Agriculture, Topeka. Div. of Water Resources.
M. J. Stell, and W. J. Anderson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 57-65, 1 fig, 3 tab.

Descriptors: *Kansas, *Water resources management, *Water use, *Water use data, Data storage and retrieval, Databases, Monitoring, Regulations, Water management.

Water resource use within the State of Kansas is monitored by means of an annual water use report program. Kansas law requires that, in order to use water, except for domestic purposes, a vested or appropriation right must be obtained. Both types of water rights require the upkeep and reporting of water use data annually, which is maintained in the Kansas Water Right Database. The procedure used to process the annual water use data is outlined along with the follow-up procedure for those water right holders not reporting. The data reported are utilized in the development and maintenance of water rights as well as for water management, regulation, planning, and research programs. Complete and accurate water use facilitate the utilization of water while protecting the resource for the future. (See also W91-04161) (Author's abstract)
W91-04168

INSTREAM FLOW ANALYSIS AND MONITORING PROCEDURE FOR LITTLE RIVER IN EASTERN TENNESSEE.
Geological Survey, Memphis, TN. Water Resources Div.
S. S. Hutson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 67-75, 5 fig, 2 tab, 8 ref.

Descriptors: *Flow measurement, *Instream flow, *Little River, *Tennessee, *Water resources management, *Water use data, Flow duration, Low flow, Monitoring, Pumping, Seasonal variation, Streamflow, Water demand, Water supply.

Competing demands for the water and seasonal variation in the flow of the Little River in Tennessee require a warning system to determine when withdrawal of water from the river threatens aquatic life downstream from the Maryville and

the Alcoa water facilities. The facilities have the combined pumping capacity to withdraw 46.4 cu ft/sec of water from Little River. The 3 day 20 year low flow computed at the Maryville gage is 46.9 cu ft/sec. Based on the analysis of flow duration values for the period of record (1953-84), minimum values at the continuous-record station near Maryville occurred from August through November; the lowest values occurred in October. October minimum values equaled or exceeded 61.6 cu ft 90% of the time. At the partial record station near Alcoa, a correlation was developed using concurrent measured and daily discharges at the continuous-record station to determine low flow frequency and duration values. The estimated 3-day 20 year low flow computed for the Alcoa gage is 52.3 cu ft/s. October minimum duration values at this site equaled or exceeded 68.9 cu ft/sec 90% of the time. A procedure for monitoring flow downstream from the gaging stations was defined and a method developed to decide when monitoring is needed. (See also W91-04161) (Author's abstract)
W91-04169

CALIFORNIA WATER-USE GEOGRAPHIC INFORMATION SYSTEM.
Geological Survey, Sacramento, CA. Water Resources Div.
W. E. Templin.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 77-84, 3 fig, 1 tab, 6 ref.

Descriptors: *California, *Geographic information systems, *Water use, *Water use data, Computer programs, Data collections, Data storage and retrieval, Databases, Water demand, Water resources data.

Geographic information system techniques are being used to develop, analyze, and integrate water-use and related information, in California. Objectives of the USGS State water use information programs address the need for both state-wide and site-specific information on water use in 12 nationally determined categories. In California, the State with the largest water use in the nation, the large volume of water used and the large number of users present major problems in meeting these objectives. The development of a site-specific database of water use information covering the entire state is an expensive process, requiring significant time and computer storage space. Until a site-specific database is developed, an interim solution is to use geographic information system techniques to integrate statewide estimates of water used in each county and hydrologic unit with localized site specific data from various sources. Geographic information system techniques can then be used to check regional estimates of site specific water use data to insure that the estimates are reasonable. The combination of geographic information system tools and a relational database also allows for rapid update of data and permits query of spatial data by user defined geographic areas to support other aspects of water resources modeling and forecasting. (See also W91-04161) (Author's abstract)
W91-04170

WATER USE IN KENTUCKY, 1985, WITH EMPHASIS ON THE KENTUCKY RIVER BASIN.
Geological Survey, Louisville, KY. Water Resources Div.
C. J. Sholar.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 85-92, 3 fig, 5 ref.

Descriptors: *Kentucky, *Kentucky River Basin, *Water demand, *Water use, *Water use data, Competing use, Consumptive use, Hydroelectric plants, Industrial water, Instream water use, Municipal water, Surface water, Water supply.

Water withdrawals in Kentucky during 1985 averaged about 4,200 million gallons/day for all offstream uses. Three water use categories (thermoelectric, public supply, and industrial) accounted for about 96% of the total offstream water use. Instream use for hydroelectric power generation averaged 91,000 million gallons/day. Data collected in 1985 supported a growing concern about potential water supply shortages in the Kentucky River Basin. This basin is the most densely populated basin in the state, and is projected to be the area of greatest future growth. Total withdrawals for offstream uses in the Kentucky River basin exceeded 253 million gallons/day in 1985 and about 95% of that amount was withdrawn from the Kentucky River and its tributaries. More than 99% of the public water supplies in the Kentucky River basin utilized surface water sources. The average surface water use in the basin in 1985 exceeded the flow near the mouth of the Kentucky River about 4% of the time. (See also W91-04161) (Author's abstract)
W91-04171

INVENTORY OF INTERBASIN WATER TRANSFERS IN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
L. C. Trotta.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 93-105, 4 fig, 2 tab, 13 ref.

Descriptors: *Interbasin transfers, *Minnesota, *Water resources management, *Water supply, *Water transfer, *Water use data, History, Water conveyance, Water demand, Water management.

Water is exported from 8 of the 13 hydrologic subregions in Minnesota examined in this study using 57 conveyances. These conveyances originate in 16 counties and range from the 4 conveyances exporting < 0.01 mgd to an export of 3.45 mgd from the City of Edina's sewer system conveyance. Four of the conveyances account for 41% of the exports between subregions. The total amount of water exported by the 57 conveyances was about 26.8 mgd in 1985. The City of Hopkins public supply conveyance, built in 1880, is the oldest conveyance. Historical trends can be examined by applying the percentage of export to historical pumpage totals available in the Minnesota Water Use Data System. The history of interbasin transfer in the drainage ditch category gives insight to the hydrologic effects of large transfers of water and provides information needed by water system managers and planners in developing water budgets. (See also W91-04161) (Lantz-PTT)
W91-04172

WATER USE ANALYSIS: ARE WATER QUALITY DATA NEEDED.
Inland Waters Directorate, Ottawa (Ontario). Water Quality Branch.
A. Demayo, D. M. Tate, and H. Vaughan.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 107-114, 3 fig, 13 ref.

Descriptors: *Data interpretation, *Water quality, *Water resources management, *Water use, *Water use data, Canada, Consumptive use, Data acquisition, Model studies, Projections, Water demand, Water supply.

In Canada, the responsibility for water resources is divided between the federal and the provincial governments. The federal government has been collecting water quantity and quality data for more than 50 years. The collection of water use quantity data was commenced by Environment Canada, a federal department, in the early 1970s. To obtain a complete picture of water use and water availability, the addition of water use quality is recommended. These quality data are essential for analyzing current water uses and projecting future uses. A simple 'mixing' water quality model combined with a 'node' water quantity model has been proposed. Anticipated difficulties in the collection and analysis of water quality data include: representativeness of the data; data aggregation; aggregation of data on the time scale; selection of significant water quality variables; water quality objectives; and the mixing model. (See also W91-04161) (Author's abstract)
W91-04173

DATA MANAGEMENT TECHNIQUES FOR SITE-SPECIFIC WATER-USE DATA IN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
N. T. Baker.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 115-121, 3 fig, 7 ref.

Descriptors: *Arkansas, *Data collections, *Data storage and retrieval, *Water resources data, *Water use, *Water use data, Computer programs, Selective withdrawal, Water demand, Wells.

The Arkansas Soil and Water Conservation Commission, in cooperation with the US Geological Survey, annually enters water use data for about 25,000 registered wells and surface water withdrawals, into Arkansas' version of the New Site-Specific Water-Use Data-Management System (NEWSWUDS). To increase the efficiency of managing large quantities of water use data, the Survey has developed several data management techniques. A computer program designed for use with the Local Applications options of NEWSWUDS was developed to help address local water use data management needs. Techniques to divide data entry among local Conservation District offices are being investigated. Designing the registration form to match the format of data entry routines, designing the Local Applications options of NEWSWUDS to be a user friendly environment for data entry personnel, dividing the task of data entry among local Conservation District offices, and employing personnel proficient at data entry have greatly increased the efficiency of data management for site specific water use data. (See also W91-04161) (Lantz-PTT)
W91-04174

WATER-USE DATA AND INFORMATION TRANSFER.
Arizona Water Resources Research Center, Tucson.
J. Gelt, R. Jenson, and L. Harris.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 123-132.

Descriptors: *Information exchange, *Information transfer, *Water resources data, *Water use, *Water use data, Public access.

To maximize its usefulness, water use data must be available to a wide and varied audience made up of researchers, managers, biologists and other water professionals. Three techniques are addressed for communicating water use data--publications, conferences and television--to people who would benefit from the information. To date, the water conference has been the most successful tool to increase name recognition and support within the water community. Contacts made through the water conference are useful to individual and agency participants in dealing with water issues in other arenas. (See also W91-04161) (Lantz-PTT)
W91-04175

WATER USE AND METHODS OF DATA ACQUISITION IN MICHIGAN.
Geological Survey, Lansing, MI. Water Resources Div.
M. J. Sweat, and R. L. Van Til.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 133-141, 3 fig, 1 tab, 13 ref.

Descriptors: *Consumptive use, *Data acquisition, *Michigan, *Water use, *Water use data, Data collections, Geographic information systems, Industrial water, Legislation, Municipal water, Selective withdrawal, Water demand, Water resources data, Water supply.

Principal water use categories in Michigan are: thermoelectric power generation, self-supplied industry, public supply, and irrigation. Water withdrawals for these categories during 1985 were estimated to be about 11,000 million gallons/day; consumptive water losses were estimated to be 590 million gallons/day. Systematic collection and analysis of water use data in Michigan began in 1970. From 1970-1986, the data collection efforts focused on compiling and analyzing data collected by various agencies, on statistical surveys of sample populations, and on projecting current withdrawals using estimates of past withdrawals. Legislation was introduced in Michigan in 1987 to improve data collection by requiring reports on all withdrawals > 100,000 gallons/day: (1) thermoelectric power generation; (2) self supplied industry; (3) public supply; and (4) irrigation. Four principal water use categories have been selected for intensive data collection during the next ten years. Future data acquisition will also include the application of a geographic information system to integrate water use databases and analyze water use. These data will be obtained through cooperative studies between the USGS, the Michigan Department of Natural Resources, and local government agencies. These efforts are expected to result in an improvement of the water use database in Michigan. (See also W91-04161) (Author's abstract)
W91-04176

COMMODITY PRICES, DEMAND CHARGES, IMPACT FEES AND WATER SERVICES.
Georgia Univ., Athens. Inst. of Natural Resources.
For primary bibliographic entry see Field 6C.
W91-04177

PRICE AND INCOME ELASTICITIES IN THE ANALYSIS OF WATER DEMANDS FOR THE CITY OF HAYS, KANSAS.
Missouri Univ.-Rolla. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W91-04178

EFFECTS OF A PUMPING TAX ON GROUND WATER DEMAND BY IRRIGATORS.
Economic Research Service, Washington, DC. Soil and Water Branch.
For primary bibliographic entry see Field 6C.
W91-04180

AGGREGATED WATER-USE DATA SYSTEM.
Geological Survey, Doraville, GA. Water Resources Div.
H. A. Perlman.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 179-184, 1 fig, 1 ref.

Descriptors: *Aggregated Water-Use Data System, *Data storage and retrieval, *Databases, *Water use, *Water use data, Data collections, Information systems, Water resources data.

The Aggregated Water-Use Data System (AWUDS) is the database management system for aggregated water use data compiled by the US Geological Survey (USGS). AWUDS was designed to store data for 118 characteristics in 12 categories of water use. Data are stored by county, water resources subregion, and water resources cataloging unit for each State, the District of Columbia, Puerto Rico, and the Virgin Islands. The files can be compiled into national files aggregated by state and water resources region. AWUDS was originally designed to compile the 1985 water use data for publication in the report 'Estimated Use of Water in the US in 1985'--one of a series of USGS circulars that have been published every 5 years since 1950. The system has since been revised to allow for entry of water use data for other years. AWUDS allows the water use specialist in each state and in the national office to obtain various tabular output of data, as well as certain graphic output, such as pie diagrams and chloropleth maps. The tables and graphics can be used to examine and interpret data and can be included directly in published reports and in presentations. (See also W91-04161) (Author's abstract)
W91-04181

DBASE III PLUS, YET ANOTHER DATA BASE FOR WATER-USE DATA.
Idaho Dept. of Water Resources, Boise.
H. N. Anderson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 185-187.

Descriptors: *Data storage and retrieval, *Databases, *Water use, *Water use data, Computer programs, Computers, Idaho, Information systems, Water resources data.

A current trend in data processing is toward a diversified structure utilizing networked workstations, stand alone personnel computers, or both. In response to changing data processing philosophies, coupled with a desire to improve efficiency, compatibility and site specificity, water use data for Idaho during 1986 was developed using dBase III Plus. dBase III Plus is one of the most commonly used database managers for personal computers and a large number of State and Federal agencies are using it, including the Idaho Department of Water Resources. This approach provides a substantial increase in efficiency and flexibility compared to previous techniques. (See also W91-04161) (Author's abstract)
W91-04182

U.S. GEOLOGICAL SURVEY'S NEW SITE-SPECIFIC WATER-USE DATA SYSTEM (NEWSWUDS).
Geological Survey, Little Rock, AR. Water Resources Div.
J. E. Terry, and M. L. Fugate.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 189-194.

Descriptors: *Data storage and retrieval, *Databases, *New Site-Specific Water-Use Data System, *Water resources data, *Water use, *Water use data, Data collections, Information systems, Water demand, Water quality, Water supply.

The US Geological Survey (USGS) collects, stores, interprets, and disseminates site specific water use data as well as many other types of water resources data related to the quantity and quality of ground and surface waters. Some of the water use data are collected by USGS personnel, however much of it is collected and made available through cooperative programs with other Federal agencies, State agencies, municipalities, water improvement districts, and others. The USGS has developed and maintains an operational database system called New Site Specific Water-Use Data System (NEWSWUDS). The system supports a multiuser, multipurpose environment, a batch/edit update system, a tabular format and a sequential file retrieval subsystem, a nationally supported applications subsystem, a local applications subsystem, and a maintenance subsystem. The NEWSWUDS is entirely 'menu' and 'shopping list' driven. There is interactive documentation available and interactive help is supported at every level. The system supports movable data bases and can handle from 1 to 99 multiple databases. (See also W91-04161) (Author's abstract)
W91-04183

KNOWLEDGE-BASED SYSTEMS FOR WATER RESOURCES MANAGEMENT.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
P. D. Scarlatos.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 195-201, 16 ref.

Descriptors: *Databases, *Expert systems, *Water resources data, *Water resources management, *Water use data, Artificial intelligence, Computer programs, Data acquisition, Data interpretation, Model studies.

Management of water resource systems requires the manipulation of a variety of complex and multi-discipline data and information. The data are usually a combination of alpha-numeric as well as qualitative data such as empirical rules, facts, beliefs or past experiences. Knowledge based systems can be efficiently used to incorporate these types of data. In addition they can be applied for data collection and processing, user friendly declarative computer modeling, engineering and environmental analysis, design, operation, planning, funding administration and legal advise. Combinations of quantified and unquantified, conditional and unconditional propositions can capture the knowledge required for the representation, analysis and management of water resource systems. Intelligent decisions and conclusions can be reached through the inference-engine of the knowledge based system. A prototype knowledge based system written in Prolog is currently being applied to hydrologic data analysis and management. (See also W91-04161) (Author's abstract)
W91-04184

SURFACE-WATER CONTAINMENT ROUTING USING A DIGITAL STREAM INFORMATION SYSTEM.
Geological Survey, Portland, OR.
For primary bibliographic entry see Field 5B.
W91-04185

USE OF GEOGRAPHIC INFORMATION SYSTEM FOR REAGGREGATING WATER-USE DATA FROM COUNTIES TO HYDROLOGIC UNITS.
Geological Survey, Reston, VA.
K. J. Lanfear, and D. S. Knopman.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 217-222, 7 ref.

Descriptors: *Databases, *Geographic information systems, *Water resources data, *Water use, *Water use data, Computer programs, Consumptive use, Data interpretation, Information systems, Maps, Water demand, Water supply.

In many water resource studies, it is necessary to reaggregate data collected on a county basis to hydrologic units. Because county boundaries rarely are identical to drainage basin divides, surrogate variables, such as area of population, commonly are used to weigh and distribute hydrologic data. A geographic information system was used to combine data bases of county boundaries, hydrologic unit boundaries, and population in the conterminous United States. Subsequently, conversion tables that list the percentage of each county's area or population within each hydrologic unit were produced and used to reaggregate estimated water use during 1985 from the county boundaries to hydrologic boundaries. Substantial differences in the estimated water use within hydrologic units occur when reaggregation based on area is compared to reaggregation based on population. Results also indicate that reaggregation techniques that assign aggregate data from each county to a single hydrologic unit could induce serious errors if used to compute values for hydrologic variables. Digital maps of counties and hydrologic units that have greater resolution than those currently available will not significantly improve the accuracy of reaggregating county data to hydrologic units. (See also W91-04161) (Author's abstract)
W91-04186

COLOR-GRAPHICS BASED WATER DEMAND FORECASTING MODEL.
Utah State Univ., Logan. Dept. of Civil Engineering.
A. B. Bishop, T. C. Hughes, H. H. Fullerton, R. D. Hansen, and M. D. Su.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American

Water Resources Association, Bethesda, Maryland. 1988. p 223-232, 6 fig, 1 tab, 4 ref.

Descriptors: *Forecasting, *Graphical methods, *Maps, *Model studies, *Regional planning, *Utah, *Water demand, *Water resources management, *Water use data, Consumptive use, Economic aspects, Land use, Population dynamics, Salt Lake Valley, Social aspects, Water resources data, Water use.

A water demand forecasting model has been developed and implemented for three communities in the Salt Lake Valley of Utah. The computer graphics model uses a base map of the region which is overlayed with land use, zoning and water service area pressure zones. Water demand sectors, e.g., single and multi-family residential, commercial, industrial, and irrigation are modeled separately. Demand functions are statistically estimated from data gathered on the characteristics of each demand sector, historical water use, and prices. The demand functions are associated with appropriate land use/water demand sectors on the geographic overlays. The model is used to forecast water demand in two modes: (1) Using population projections and economic forecasts for the communities distributed geographically by various land use categories; and (2) Designated changes in land use or zoning to accommodate additional development of various types. In addition, exogenous parameters in the demand function, such as the price of water, are altered to evaluate changes in demand in response to changes in socioeconomic conditions. Designed as a user interactive model, planners and water managers can evaluate a range of scenarios of population growth and economic development for the communities. (See also W91-04161) (Author's abstract)
W91-04187

GROUND-WATER BANKING IN KERN COUNTY, CALIFORNIA.
Kern County Water Agency, Bakersfield, CA.
For primary bibliographic entry see Field 4B.
W91-04190

WATER CONSERVATION, MYTH OR MANDATE, AN ARID SOUTHWEST PERSPECTIVE.
Las Vegas Valley Water District, NV.
T. Katzer, and K. Brothers.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 273-281, 4 fig, 1 tab, 7 ref.

Descriptors: *Groundwater level, *Groundwater mining, *Water conservation, *Water resources management, *Water use, *Water use data, Aquifers, Colorado River, Consumptive use, Groundwater resources, Hydrologic budget, Las Vegas, Nevada, Semiarid lands, Subsidence.

Water use data for Las Vegas Valley, Clark County, Nevada, is considered. Overdrafting the groundwater system, coupled with the importation of large quantities of Colorado River water, has produced quasi-scientific paradoxes. As the water table declines in the deep, principal aquifer on the west side of the valley, as a result of large groundwater withdrawals (causing subsidence), the overlying shallow aquifer poses a threat in two ways: (1) on the west side of the valley, water from the shallow aquifer percolates down to the principal aquifer as secondary recharge and degrades the water quality; and (2) in the central and eastern parts of the valley, the secondary recharge causes the water table in the shallow aquifer to rise and become a geologic hazard when the water table intersects land surface. Recent water use data indicate a total water use of about 350 gal/day/person. Immediate implementation of conservation measures are required in order to solve hydrologic problems. (See also W91-04161) (Lantz-PTT)
W91-04192

WATER USE IN EIGHT CENTRAL PENNSYLVANIA HOMES.
Pennsylvania State Univ., University Park. Environmental Resources Research Inst.
E. M. Seaker, and W. E. Sharpe.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 283-294, 5 tab, 36 ref. EPA Contract CR807115-01.

Descriptors: *Domestic water, *Pennsylvania, *Water use, *Water use data, Consumptive use, Water conservation, Water demand.

The water use of eight central Pennsylvania homes was intensively monitored during spring and summer 1980 as part of a study to determine the impact of water conservation devices on waste flow volumes. Key water using features and appliances, outside hose bibbs and total household water use were monitored for a 28 day period in each home. Mean daily per capita water use for toilet flushing, showering and bathing and clothes washing were higher than literature values; and mean per capita water use for all water use activities combined were higher than that for any study reporting comparable data. As expected, outdoor water use for homes without swimming pools was small relative to other uses. Assessed home value was strongly correlated with water use, but family size was not. Water use did not appear to be affected significantly by use of on-lot sewage disposal systems. (See also W91-04161) (Author's abstract)
W91-04193

RESIDENTIAL WATER USE STUDY OF LUBBOCK, TEXAS.
Texas Tech Univ., Lubbock. Dept. of Civil Engineering.
B. J. Claborn, K. M. Trauth, R. L. West, and L. V. Urban.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 295-306, 4 fig, 6 tab, 3 ref.

Descriptors: *Domestic water, *Lubbock, *Texas, *Water use, *Water use data, Consumptive use, Forecasting, Seasonal variation, Water demand, Water resources management.

Instantaneous flow rates for ten single family residences in the City of Lubbock, Texas were collected over an 18 month period. The three highest use rates during each day were analyzed in an effort to determine a maximum winter use rate which could be related to socioeconomic factors. Patterns of use based on the day of the week were observed but without correlation to known factors. Use rates were also compared to city wide use rates and the conclusion drawn that variability between individual households is too large to allow projection of use based on small samples. (See also W91-04161) (Author's abstract)
W91-04194

WATER SUPPLY MANAGEMENT AND PLANNING IN THE STATE OF CONNECTICUT.
Whitman and Howard, Inc., Wellesley, MA.
For primary bibliographic entry see Field 6A.
W91-04196

WATER DISTRIBUTION SYSTEMS ANALYSIS: SPECIFIC CONSIDERATIONS.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
Z. Panahi, D. W. Ferguson, and D. V. Garcia.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 349-359, 3 tab, 7 ref.

Descriptors: *Planning, *Water conveyance, *Water demand, *Water distribution, *Water supply, *Water use, *Water use data, California, Computer programs, Model studies, Network design, Riverside.

A general approach to water master planning is presented with an emphasis on water distribution systems analysis. A review is made of water demands, design criteria, model preparation, model calibration and water distribution system analysis and evaluation. Based on the preparation of a Water Master Plan for the City of Riverside, California, a number of key considerations are identified. Computerized billing records, detailed water use factors, and variable peaking factors were used to analyze and forecast the City's water demands. C-value flow test data are useful in establishing specific C-values for a particular water system. Model calibration helps to ensure the reliability of the water demands and C-values used in the network model. The pressure, head loss, velocity, and reservoir flow data generated from the model results are compared to established design criteria to identify distribution system deficiencies. Recommendations as a result of the City of Riverside Water Master Plan include 13 reservoirs, 35 pump additions, 5 pressure reducing stations, and approximately 31 miles of pipeline improvements. A 12-year capital improvement program was presented in the master plan in order to prioritize and phase the recommended improvements. (See also W91-04161) (Lantz-PTT)
W91-04199

URBAN NONRESIDENTIAL WATER USE AND CONSERVATION.
Southern Illinois Univ. at Carbondale. Dept. of Geography.
B. Dziegielewski.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 371-380, 2 fig, 3 tab, 14 ref.

Descriptors: *Consumptive use, *Industrial water, *Municipal water, *Urban areas, *Water use, *Water use data, Population dynamics, Water distribution.

Urban nonresidential users of water may account for 30-50% of water distributed by public systems. Because the data on water requirements by different categories of nonresidential users are limited, water agencies may encounter difficulties in forecasting future water needs or in assessing the potential for water conservation. The distribution of water use among major classes of nonresidential users was examined and the feasibility of developing employee use rates for comparing water use between similar establishments was explored. The findings indicate that the number of employees and the Standard Industrial Classification of an establishment are important determinants of water use. Development of water use guidelines, based on employment for various types of manufactures and commercial or institutional users is recommended for improving management of urban water demand. (See also W91-04161) (Author's abstract)
W91-04201

PROSPECTS FOR INNOVATION IN WATER INSTITUTIONS: INFORMATIONAL REQUIREMENTS.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
For primary bibliographic entry see Field 6E.
W91-04203

GREAT LAKES REGIONAL WATER-USE DATA BASE--A WATER-RESOURCES MANAGEMENT TOOL.
Geological Survey, Albany, NY. Water Resources Div.
D. S. Snavely.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 397-406, 3 fig, 2 tab, 7 ref.

Descriptors: *Databases, *Great Lakes, *Water resources data, *Water resources management, *Water use, *Water use data, Consumptive use, Data collections, Data storage and retrieval, International commissions, Selective withdrawal, Saint Lawrence River Basin, Water managements.

The Great Lakes-St. Lawrence River Basin includes parts of nine states and two Canadian prov-

inces. In 1985, the governors and premiers signed the Great Lakes Charter, which established a broad protection strategy to manage the basin's water resources. Among the Charter's mandates was the establishment of a regional water use database, which was designed by the USGS in 1986, and is housed at the Great Lake's Commission in Ann Arbor, Michigan. The database stores annual data on withdrawals, consumptive uses, and diversions in each state and province by water use category, source and sub-basin. To comply with the Charter, the states and provinces must be able to: (1) collect accurate water use data from major facilities; and (2) have the authority to regulate or permit consumptive use projects and diversions. The data obtained under the first provision are stored in the database. Compliance with these stipulations grants the states and provinces the right to participate in joint discussions of the advisability of allowing the construction of major consumptive use or diversion projects. Data from the database can be used as input to hydrologic response models to assist in basinwide water resources management. (See also W91-04161) (Author's abstract)
W91-04204

WATER USE DATA REQUIREMENTS AND SOURCES FOR APPRAISAL OF WATER RIGHTS YIELDS.
Rice (Leonard) Consulting Water Engineers, Inc., Denver, CO.
G. S. Ten Eyck.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 437-446, 2 fig, 5 ref.

Descriptors: *Water resources data, *Water rights, *Water supply, *Water use, *Water use data, Arizona, Colorado, History, Indian reservations, Marketing, Water demand, Water transfer, Water yield.

Interest in quantifying or appraising the yield of a water right has increased in the last several years as a result of the increased incidence of water rights transfers. Notable examples of recent water rights marketing have included 'water ranching' by Arizona municipalities, the continued acquisition of agricultural water rights by Colorado Front-Range municipalities, and the proposed marketing of Indian water rights. Implicit in the water rights marketing concept is the ability to document the yield of a water right, and therefore establish a cost per acre-foot of the water right being marketed for transferal. Comparing the yield of one water right to the yield of another is difficult; methodologies for establishing a common basis of comparison are employed. However, they are obviously data intensive. A description is provided of water use data requirements for an evaluation methodology which has been used in several states and under diverse circumstances. Data needs include: (1) data to define historic use; (2) available water supply; (3) estimation of actual beneficial use; (4) entitlement to historic use; (5) estimation of historic return flows; and (6) the amount that is transferable. (See also W91-04161) (Lantz-PTT)
W91-04208

OPTIMAL WATER ALLOCATION IN THE LAKES BASIN OF NICARAGUA.
Centro Agronomico Tropical de Investigacion y Ensenanza, Turrialba (Costa Rica). Integrated Natural Resources Management Program.
C. Gutierrez.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 465-477, 3 fig, 4 tab, 5 ref.

Descriptors: *Nicaragua, *Water allocation, *Water demand, *Water resources management, *Water supply, *Water use data, Competing use, Industrial water, Irrigation water, Lake Managua, Lake Nicaragua, Social aspects, Water transfer, Water use.

The water resources of Nicaragua are largely undeveloped and distributed unequally throughout the nation. In addition, there is a significant geographical imbalance between the abundant water supply in the Atlantic Basin, and the less abundant supply in the Pacific Basin, which accounts for most of the water demand. The Lakes Basin, comprised of Lakes Managua and Nicaragua, could be manipulated to solve the imbalance. A scheme is presented to transfer water from Lake Nicaragua to Lake Managua and, subsequently, direct water from each lake for irrigation and hydroelectric generation. The scheme has been designed to maximize economic benefits and minimize environmental impacts. Application of the scheme would require: (1) the establishment of budget constraints of the project; (2) definition of the actual requirements of irrigated land as well as the energy needs of the country during the planning period; (3) an accounting of the future water demands in the basin for domestic and industrial uses; and (4) an accounting of the social and indirect benefits arising from recuperation of Lake Managua. (See also W91-04161) (Lantz-PTT)
W91-04211

USE OF BASE-FLOW DATA TO MANAGE WATER USE DURING A DROUGHT.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 2E.
W91-04213

RESOURCE MANAGEMENT TO ACCOMMODATE MULTIPLE USE OF STREAMFLOW IN THE RIO CHAMA, NEW MEXICO.
Bureau of Reclamation, Albuquerque, NM. Water Accounting and Reservoir Regulation Branch.
L. P. Walkoviak, and M. A. Hamman.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 517-522, 1 tab.

Descriptors: *Competing use, *Nonstructural alternatives, *Reservoir operation, *Rio Chama, *Water resources management, *Water use, *Water use data, Abiquiu Reservoir, El Vado Reservoir, Irrigation water, Municipal water, New Mexico, Recreation, Streamflow, Water demand, Water rights, Water supply.

During the past several years, innovative water management options have been explored and implemented to facilitate multiple water uses among municipal, industrial and irrigation water users, white water rafters, kayakers, and fish and wildlife interests among the Rio Chama between El Vado and Abiquiu reservoirs in New Mexico. El Vado Reservoir is operated by the US Bureau of Reclamation. Water from the Reclamation's San Juan-Chama Project, as well as natural streamflow, are the water supply that is managed. El Vado Reservoir is upstream of Abiquiu Reservoir and these facilities store significant amounts of San Juan-Chama water. San Juan-Chama water is imported from the upper Colorado River basin. Historical river and reservoir operations are reviewed and compared with recent water management innovations. Operational options implemented have included: adjustments to contract delivery dates for San Juan-Chama water, flexible water sharing between water rights holders and entities who hold storage allocations in either or both reservoirs, and formal and informal operating agreements between various city, state and federal agencies. Results to date have included improvements in the in-stream fishery hatch and survival rates for certain species, and several weekends of raftable white-water flows each summer during times when natural flows are historically low. (See also W91-04161) (Author's abstract)
W91-04216

VIRGIN RIVER: PLANNING FOR DEVELOPMENT WHILE MEETING FLOW REQUIREMENTS FOR ENDANGERED SPECIES.
Utah Dept. of Natural Resources, Salt Lake City. Div. of Water Resources.
N. E. Stauffer, R. L. Tullis, and L. H. Austin.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 523-535, 11 fig.

Descriptors: *Ecological effects, *Endangered species, *Management planning, *Site selection, *Streamflow, *Virgin River, *Water resources development, *Water use data, Indian reservations, Model studies, Recreation, Reservoir siting, Semiarid regions, Utah, Water demand, Wildlife conservation.

The Virgin River Basin in southern Utah, particularly the St. George area, has experienced rapid growth as a recreation and retirement location during the last 15 to 20 years. This has created new water demands in a water short, semiarid area that has a long history of difficulty in water development. Meeting these demands is complicated by the many national and state parks as well as the forest, Bureau of Land Management (BLM), and Indian lands that are in close proximity to the Virgin River. Further complicating the issue is the listing of the Woundfin as an endangered species and the proposed listing of the Virgin River Chub as an endangered species. A widespread effort is underway to address these issues using techniques such as: a river basin study pertaining to water, soil, and related resources; a biological study of the native fish; and computer modeling of fish habitat and water development. The modeling effort includes simulating existing and potential reservoir sites for evaluating the effects of water development on endangered fish habitats with minimum flow constraints. (See also W91-04161) (Author's abstract)
W91-04217

WATER TRANSFERS IN ARIZONA: ASSESSING THE ADVERSE EFFECTS ON AREAS OF ORIGIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
E. Checchio, and S. C. Nunn.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 547-559, 6 tab, 8 ref.

Descriptors: *Arizona, *Social aspects, *Water resources development, *Water supply, *Water transfer, *Water use data, Competing use, Consumptive use, Economic aspects, Irrigation, Model studies.

Tens of thousands of acres of irrigated farmland in rural Arizona have been purchased over the past few years with the hope of transporting the associated water to cities. Many Arizonians believe that this 'water farming' can solve Arizona's water supply problems by transferring water supplies to areas of greatest need. Others fear that water transfers will have serious adverse effects on rural government, economies and environments. To evaluate the effects of transfers their path must be traced through the regional economy and environment. This requires sophisticated econometric and hydrologic modeling and detailed data. It is possible to make interregional comparisons with much less data, contrasting regional sensitivity to particular categories of effects. The most important categories to address are economic, fiscal, environmental and limitations on future development potential. An index is constructed of sensitivity to economic effects based on readily available secondary data. The values for this index are calculated for four counties in Arizona: La Paz, Maricopa, Pima, and Pinal. Indices of sensitivity to fiscal, environmental, and future development effects would have to be included in order to evaluate a region's relative sensitivity to water transfers. (See also W91-04161) (Author's abstract)
W91-04219

RELIABILITY IN MARKET TRANSFERS OF MUNICIPAL WATER SUPPLIES.
Colorado Coll., Colorado Springs. Dept. of Economics and Business.
M. G. Smith.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland.

1988. p 561-570, 1 fig, 23 ref.

Descriptors: *Marketing, *Model studies, *Municipal water, *Stochastic models, *Water supply, *Water transfer, *Water use data, Economic aspects, Performance evaluation, Water resources management.

Analytical methods for evaluating the problem of market transfer are developed using three models of bilateral transactions between domestic supply authorities. The first is a deterministic allocation model which maximizes social welfare. The second model is a normative economic model of efficient allocation under uncertainty, and the third model, in contrast to the two previous models, is a revenue maximization model reflecting the self interest of water authorities. The primary contribution of this work is the development of a stochastic spatial equilibrium model to analyze transactions between water authorities with respect to economic and reliability objectives. This approach fills the need for a model that incorporates the performance criterion of the welfare economist, allocative efficiency, and the performance criterion of water managers. (See also W91-04161) (Lantz-PTT)
W91-04220

PLANNING FOR USE OF UNCONVENTIONAL WATER SOURCES.
Electric Power Research Inst., Palo Alto, CA. Planning and Evaluation Div.
For primary bibliographic entry see Field 3E.
W91-04223

WATER RESOURCES AND THE ELECTRIC POWER INDUSTRY: AN AUSTRALIAN PERSPECTIVE.
For primary bibliographic entry see Field 3E.
W91-04224

INDUSTRIAL WATER USE AND STRUCTURAL CHANGE.
Inland Waters Directorate, Ottawa (Ontario). Water Planning and Management Branch.
For primary bibliographic entry see Field 3E.
W91-04225

PRACTICAL APPLICATION OF THE WATER BALANCE APPROACH FOR MEASURING CANAL CONVEYANCE LOSSES.
Rice (Leonard) Consulting Water Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 3F.
W91-04226

NATURAL CONSUMPTIVE USE BY TULES, GRASSLANDS, AND RIPARIAN FORESTS, CALIFORNIA CENTRAL VALLEY.
For primary bibliographic entry see Field 2I.
W91-04227

CONSUMPTIVE USE ESTIMATES IN REGIONAL POLICY RESEARCH.
Economic Research Service, Washington, DC. Soil and Water Branch.
N. R. Gollehon.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 633-640, 19 ref.

Descriptors: *Consumptive use, *Policy making, *Public policy, *Water resources management, *Water use data, Water resources development.

The role of consumptive use estimates in influencing water resource decisions is explored. Past uses of consumptive use estimates are contrasted with needs to address water resource issues in the current and future decision making environment. Public policy analysts may have problems using consumptive use estimates that were developed for use by irrigation developers and irrigated producers, who have historically required increasing absolute accuracy for a small geographic area. Point accurate estimators most appropriate for historical uses are not well suited to public policy analysis which is broader in geographic coverage and focuses on relative change due to policy action. Current estimation methods have also supplied consumptive use estimates for on-farm water management information. These techniques have focused correctly on developing increasingly precise estimates for a shrinking geographic area. (See also W91-04161) (Lantz-PTT)
W91-04228

ESTIMATION OF SURFACE-WATER WITHDRAWALS FOR IRRIGATION AND IRRIGATED ACREAGE, 1985, GALLATIN COUNTY, MONTANA.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 3F.
W91-04229

FLOAT-POT ASSEMBLY TO MEASURE WATER LEVELS IN AN IRRIGATION CANAL.
Agriculture Canada, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 7B.
W91-04230

ESTIMATION OF GROUND-WATER USE FOR IRRIGATION IN EASTERN WASHINGTON USING LANDSAT IMAGERY.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 3F.
W91-04232

APPLICATION OF REMOTE SENSING AND GIS TO ESTIMATE IRRIGATION WATER USE IN THE UPPER GUNNISON RIVER BASIN IN COLORADO.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 3F.
W91-04233

SPUDS FROM SPACE: USING REMOTE SENSING/GIS IN ADJUDICATING IDAHO WATER RIGHTS.
Idaho Dept. of Water Resources, Boise. Land and Water Use Data Section.
For primary bibliographic entry see Field 6E.
W91-04235

STATE WATER DEMAND METHODOLOGY, KANSAS, 1987.
Kansas Water Office, Topeka.
D. L. Eklund, and T. K. Rajala.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 711-721, 1 fig, 2 tab, 9 ref.

Descriptors: *Competing use, *Data interpretation, *Kansas, *State jurisdiction, *Water demand, *Water use data, Agricultural water, Consumptive use, Domestic water, Forecasting, Industrial water, Irrigation water, Management planning, Mining water, Municipal water, Water use.

A methodology is presented used by the Kansas Water Office to estimate the present and future water demand in the state. Projections were made for a 56 year planning period, from 1984-2040. The methodology for water demand estimates and projections was provided for public, industrial, mining, electric power generation, irrigation and livestock water use. Population projections were made for the planning period for each county and river basin. OBERS population projections for the state were used as a constraint. Public water demand was projected as a function of population and per capita usage. Industrial and mining water demand were projected as a function of 1984 water use and future employment ratios, water recirculation ratios and employee productivity ratios. Electric power generation water demand projections utilized individual plant projections and population projections. Irrigation water demand was projected on the basis of 5 factors: irrigation appropriation, irrigation system, farm operation, soil and plant characteristics, and crop production. Livestock water demand was projected as a function of the projected number of livestock and average water use per head. (See also W91-04161) (Author's abstract)
W91-04236

WATERSHED MODELING FOR WATER RESOURCES MANAGEMENT.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 6A.
W91-04237

MAIN II-MODEL WATER-USE PROJECTIONS FOR WISCONSIN, 1990-2010.
Wisconsin Dept. of Natural Resources, Madison. Bureau of Water Resources Management.
J. Prey.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 733-741, 4 fig, 7 tab, 18 ref.

Descriptors: *Forecasting, *Model studies, *Water demand, *Water use, *Water use data, *Wisconsin, Competing use, Data interpretation, Industrial water, Municipal water, Simulation analysis.

The Wisconsin Department of Natural Resources and the US Army Corps of Engineers have cooperatively projected water demand for Wisconsin. A new methodology was developed to project this demand. The Municipal and Industrial Needs Model (MAIN II) developed by the Corps, was modified to project water demand on a county-wide basis. Prior to this, the model was only capable of projecting water demand for municipalities. The modification to the Main II model required adding additional water use categories to the model and aggregating data on a county-wide basis. Projections were made to the year 2010, using 5 year intervals. The results of the modified Main II model were satisfactory. Certain water use categories are projected to have large annual growth rates than others. Irrigation will increase by 53.49%, the largest increase for a water use category. Concurrently, residential use will increase by 17.19%, the smallest increase for the state. In terms of the volume, industrial water use will have the largest increase, with 41.767 billion gal/yr, and livestock will have the smallest increase with 6.549 billion gal/yr. (See also W91-04161) (Lantz-PTT)
W91-04238

ANALYSIS OF THE VARIABLES AFFECTING WATER CONSUMPTION FOR THE CITY OF HAYS, KANSAS.
Missouri Univ.-Rolla. Dept. of Civil Engineering.
S. M. Tillman, and R. Bryant.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 759-771, 3 tab, 12 ref.

Descriptors: *Consumptive use, *Data interpretation, *Hay, *Kansas, *Water demand, *Water use, *Water use data, Economic aspects, Model studies, Social aspects.

A model was developed to evaluate the municipal water demand for the City of Hays, Kansas. The study consists of two phases. The first is to develop a relationship between income and other variables to the demand for water. The variables chosen were derived from literature and included: family income; climate factors, summer precipitation; household factors, number and size of residential housing units; price of water; and water loss. Results indicated that family income represents the best variable for describing water consumption. Other variables found to be important included: summer precipitation, residents per occupied housing unit, and lagged consumption. The price of water was not included due to limitation of data. (See also W91-04161) (Lantz-PTT)
W91-04240

NUMERICAL ANALYSIS OF COMPLEX PIPE SYSTEM WITH TWO PUMPS CONNECTED IN PARALLEL.
Bitola Univ. (Yugoslavia). Tehnicki Fakultet.
For primary bibliographic entry see Field 8A.
W91-04241

FORECASTING MUNICIPAL WATER DEMAND AND CONSERVATION EVALUATION: THE IWR-MAIN SYSTEM 5.1.
Planning and Management Consultants Ltd., Carbondale, IL.
W. Y. Davis.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 787-795, 2 tab, 3 ref.

Descriptors: *Computer models, *Data interpretation, *Forecasting, *Model studies, *Municipal water, *Water conservation, *Water demand, *Water use data, Computer programs, Management planning, Water resources management, Water supply, Water use.

The IWR-MAIN forecasting models are sensitive to many determinants of water demand which facilitate the preparation of alternative forecasts under varied assumptions. Optional input data may be provided to enhance or improve estimation procedures, and various combinations of forecasting methods may be selected. Furthermore, coefficients used in the estimation of water use are stored in library files and are therefore accessible for updating or adjusting to local conditions. Reliable forecasts of water use are essential for water planning needs and water policy decisions. The forecast results produced by the IWR-MAIN system can provide water planners and water supply agencies with data which may be used to: (1) plan for the expansion of a system capacity (sources, transmission, treatment); (2) size and expand the distribution systems (network design problems); (3) prepare contingency plans for water shortages caused by droughts or source contamination; (4) evaluate the effectiveness (or water savings) of alternative conservation measures; (5) perform sensitivity analyses with varying assumptions about the prices of water, weather conditions, and other determinants of water use; and (6) assess utility revenues with improved precision. (See also W91-04161) (Lantz-PTT)
W91-04242

UNCERTAINTY OF WATER SUPPLY DEMAND ESTIMATES.
Polytechnic Univ., Brooklyn, NY. Dept. of Civil and Environmental Engineering.
A. S. Goodman, A. Machlin, and M. Karamouz.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 797-803, 18 ref.

Descriptors: *Data interpretation, *Forecasting, *Water demand, *Water supply, *Water use data, Mathematical analysis, Performance evaluation, Statistical analysis, Water resources management.

There has been a generally unquestioning reliance on traditional engineering approaches in the forecasting of water demands which does not adequately reflect the uncertainty of variables entering into their determination. Reports on ongoing research to develop an improved understanding of traditional and newer methodologies for estimating water demands are made, which also include the evaluation of strengths and weaknesses for preparing water management strategies. The approaches considered include sensitivity analyses, risk analyses, Markovian and non-Markovian time series, Bayesian decision theory, and other mathematical approaches. (See also W91-04161) (Author's abstract)
W91-04243

WATER SUPPLY FORECASTING AND ITS UNCERTAINTIES.
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.
M. Roos.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 805-814, 3 fig, 1 tab, 2 ref.

Descriptors: *Data interpretation, *Forecasting, *Water supply, *Water use data, Mathematical analysis, Performance evaluation, Water resources management, Weather.

Next year's mountain water supply in the West is primarily a result of the rain and snow during the winter wet season which is largely unknown early in the water year. Therefore water supply forecasts are normally comprised of a median outlook and a range to give water users a better estimate, and the probable range of, runoff. The ranges are progressively narrowed during the season to account for the increasing amount of known weather and the reduced amount of uncertainty in future weather. Total forecast error at any time can be viewed as a vector with a component for future weather and one for procedural errors in the forecasting methodology. To the extent that reliability is demonstrated, long-range weather forecasts can be worked into the procedures to shift results from the conventional forecast projection which assumes normal random distribution of future weather, to a value partially reflecting the weather forecast. (See also W91-04161) (Author's abstract)
W91-04244

PHOENIX WATER RESOURCE PLAN--1987.
Phoenix City Water and Wastewater Dept., AZ.
For primary bibliographic entry see Field 6A.
W91-04245

REGIONAL COOPERATION IN THE USE OF IRRIGATION WATER: EFFICIENCY AND INCOME DISTRIBUTION.
Hebrew Univ. of Jerusalem, Rehovoth (Israel). Faculty of Agriculture.
For primary bibliographic entry see Field 6C.
W91-04436

COMPARATIVE STATISTICAL VALIDATION OF TWO TEN-DAY WATER-USE MODELS AND OF THREE YIELD-REDUCTION HYPOTHESES FOR YIELD ASSESSMENT IN BOTSWANA.
Ghent Rijksuniversiteit (Belgium). Faculteit Landbouwwetenschappen.
P. Vossen.
Agricultural and Forest Meteorology AFMEEB, Vol. 51, No. 2, p 177-195, June 15, 1990. 2 fig, 5 tab, 33 ref.

Descriptors: *Agricultural hydrology, *Botswana, *Crop yield, *Hydrologic models, *Model studies, *Soil-water-plant relationships, *Water use, Agronomic crops, Cereal crops, Comparison studies, Corn, Hay, Hydrologic budget, Model testing, Planting management, Soil water, Sorghum, Statistical analysis, Water deficit, Water stress, Yield equations.

The 1978/1979-1985/1986 cereal yields of five regions in Botswana were statistically analyzed as a function of two water-use models and three yield-reduction hypotheses. The first model does not include a root development model and assumes that all available soil moisture is readily available. The second model includes a simple root development function and assumes that only part of the maximum available soil moisture is readily available. Simultaneously, three hypotheses were tested regarding the effects of water stress on yield. The first hypothesis accepts that yield reduction is related to cumulative deficit. The second hypothesis accepts that yield reduction is affected differently by water stress, depending upon the development stage during which the stress occurs, and the final effect is additive. The third hypothesis is as the second, but assumes that the final effect is multiplicative. The results show that for the period under consideration: (1) the two water-use models equally account for yield variability in Botswana; (2) sorghum + millet yield variability is better accounted for when introducing different additive-stage susceptibilities to water stress; (3) maize yield variability is significantly better accounted for when water deficit experienced during the reproductive stage is multiplied by the square of the deficit experienced during the vegetative stage; (4) subject to some restrictions, quantitative crop yield assessments are possible on a national scale; on a regional scale, qualitative crop state monitoring is indicated; and (5) water stress during the 1978/1979-1985/1986 rainy seasons significantly depressed a positive time trend. (Author's abstract)
W91-04485

REALIZING THE BENEFITS OF WATER REUSE IN DEVELOPING COUNTRIES.
Camp, Dresser and McKee, Inc., Raleigh, NC.
For primary bibliographic entry see Field 3C.
W91-04604

U.S. WATER REUSE: CURRENT STATUS AND FUTURE TRENDS.
CH2M/Hill, Denver, CO.
For primary bibliographic entry see Field 3C.
W91-04605

ROLE OF THE FIRE MARSHAL'S OFFICE.
E. Bacon.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 208-210, September 1990.

Descriptors: *Connecticut, *Firefighting, *Water conservation, *Water use, Fire marshals, Public health, Sprinklers.

The role of the Fire Marshal was reviewed by a fire safety expert, and ways for firefighters and the water supply industry can work together to not only make firefighting safer and more effective but conserve water as well are suggested. In the state of Connecticut, a Fire Marshal must be certified as a result of prescribed training and must continue his/her education to maintain his/her certification. The installation of automatic sprinklers is recommended and should be encouraged by means of legislation and incentives in the form of reduced insurance premiums, trade-offs in construction requirements, and more freedom for the architect in design. By installing automatic sprinklers, water is applied to a fire during the incipient stage long before 'flash over.' This approach not only saves lives, but saves the water that would be applied by hose streams, deluge sets, and ladder pipes and the resulting millions of gallons of water that flows down the storm drains or freezes in the parking lot. (White-Reimer-PTT)
W91-04843

PUBLIC WATER SUPPLY DEMAND MANAGEMENT--AN ACT OF OPPRESSION.
Rhode Island Water Resources Board, Providence.
P. P. Calise.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 3, p 211-213, September 1990.

Descriptors: *Resources management, *Water demand, *Water supply, Economic aspects, Market economics, Utilities.

It is suggested that the water supplier should provide water to the consumer in an economical, efficient, and effective manner. Conservation, that is the efficient use of a water supply, is an essential part of every public water utility's supply management. For too long, suppliers have been burdened with the idea that their goal was to provide a supply to the market place at a cost most favorable to the consumer. In effect, the consumer, the demand, has managed the supply in the market place. The supplier should operate on an enterprise fund basis and implement management practices which warrant that the product sold is priced at the true cost of producing and delivering the water as measured through sound metering practices and devices. To this end, public water utilities should adopt, consistent with appropriate business practices, development and conservation supply man-

agement tools to produce and deliver to their markets a water supply for today and tomorrow without interfering with and/or suppressing the consumer's rights to enter or leave the said markets at his or her discretion. To do otherwise, only means demand management will be deemed appropriate and acts of oppression will be common place. (White-Reimer-PTT)
W91-04844

WATER TRANSFER PROCESS AS A MANAGEMENT OPTION FOR MEETING CHANGING WATER DEMANDS.
Colorado Univ. at Boulder. Natural Resources Law Center.
For primary bibliographic entry see Field 6E.
W91-04886

MARGINAL ECONOMIC VALUE OF STREAMFLOW: A CASE STUDY FOR THE COLORADO RIVER BASIN.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
T. C. Brown, B. L. Harding, and E. A. Payton.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2845-2859, December 1990. 1 fig, 5 tab, 47 ref.

Descriptors: *Colorado River Basin, *Economic aspects, *Economic evaluation, *Model studies, *Streamflow, *Water use, Case studies, Flow models, Forest watersheds, Hydroelectric power, Marginal costs, Salinity, Value.

The marginal economic value of streamflow leaving forested areas in the Colorado River Basin was estimated by determining the impact on water use of a small change in streamflow and then reapplying economic value estimates to the water use changes. The effect on water use of a change in streamflow was estimated with a network flow model that simulated salinity levels and the routing of flow to consumptive uses and hydroelectric dams throughout the Basin. The results show that, under current water management institutions, the marginal value of streamflow in the Colorado River Basin is largely determined by nonconsumptive water uses, principally energy production, rather than by consumptive agricultural or municipal uses. Given current institutions, the year 1990 consumptive use request level, and reasonable variations in assumed parameters, the expected value of flow increases from timber harvest on national forest land varied from $34 to $46 per acre foot. The analysis demonstrates the importance of a systems framework in estimating the marginal value of streamflow. (Author's abstract)
W91-04913

FINITE HYDRAULIC CONDUCTIVITY EFFECTS ON OPTIMAL GROUNDWATER PUMPING RATES.
Mission Research Corp., Albuquerque, NM.
W. R. Zimmerman.
Water Resources Research WRERAQ, Vol. 26, No. 12, p 2861-2864, December 1990. 3 fig, 1 tab, 16 ref.

Descriptors: *Economic evaluation, *Groundwater movement, *Hydraulic conductivity, *Model studies, *Optimization, *Pumping rates, Aquifers, Economic aspects, Finite difference methods, Hydrologic models, Mathematical models, Resource management.

The effect of a finite hydraulic conductivity on the optimal pumping rate from a closed aquifer was examined, and a methodology which determines the optimal pumping rate of a dynamic groundwater model with complex state and control functions was developed. The economic optimal pumping rate was found by maximizing the stream of discounted social benefits from pumping. A direct optimization or maximization of the integral can be accomplished by finite difference techniques. The optimal pumping rate can be substantially lower when the hydraulic conductivity is small enough to result in a significant cone of depression. The general numerical approach used to optimize a present value with complex state and control functions may prove useful in other areas of water resources and economics. (Brunone-PTT)
W91-04914

6E. Water Law and Institutions

DEVELOPING AND PASSING STATEWIDE WELLHEAD PROTECTION PROGRAMS CONNECTICUT: A CASE STUDY.
Murtha, Cullina, Richter and Pinney, Hartford, CT.
For primary bibliographic entry see Field 5G.
W91-03922

WALPOLE BOARD OF HEALTH: GROUNDWATER PROTECTION PLAN IMPLEMENTATION.
Walpole Board of Health, MA.
For primary bibliographic entry see Field 5G.
W91-03923

FOX(BOROUGH) GUARDING THE AQUIFER COOP: LOCAL CONTROL AT WORK.
S E A Consultants, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5G.
W91-03926

EASTON'S EXPERIENCE AND THE CANOE RIVER AQUIFER ADVISORY COMMITTEE.
Easton Water Div., MA.
For primary bibliographic entry see Field 5G.
W91-03927

BRIDGEPORT HYDRAULIC COMPANY AQUIFER PROTECTION PROGRAM.
Bridgeport Hydraulic Co., CT.
For primary bibliographic entry see Field 5G.
W91-03928

EVALUATION OF LOCAL REGULATORY EFFORTS IN IDENTIFYING AND CONTROLLING THE THREAT OF UNDERGROUND FUEL STORAGE TANKS.
Barnstable County Health and Environmental Dept., MA.
For primary bibliographic entry see Field 5G.
W91-03935

EPA/LOCAL PARTNERSHIP AT WORK - THE CREATION OF A GROUND WATER PROTECTION PROGRAM.
Environmental Protection Agency, Philadelphia, PA. Region III.
For primary bibliographic entry see Field 5G.
W91-03938

MODEL COMMUNITY PROGRAM FOR PRIVATE WELLS.
Connecticut Univ., Storrs. Cooperative Extension System.
For primary bibliographic entry see Field 5G.
W91-03941

BOARDS OF HEALTH PROTECTION FOR PRIVATE WELLS AND GROUNDWATER.
Massachusetts Association of Health Boards, Plainville.
For primary bibliographic entry see Field 5G.
W91-03942

WATER-USE EFFICIENCY STANDARDS FOR PLUMBING FIXTURES: BENEFITS OF NATIONAL LEGISLATION.
Brown and Caldwell, Boston, MA.
For primary bibliographic entry see Field 3D.
W91-03972

CALIFORNIA'S PROPOSITION 65: EXTRAPOLATING ANIMAL TOXICITY TO HUMANS.
California Univ., Davis. Dept. of Environmental Toxicology.
W. W. Kilgore.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 491-494, 1990.

Descriptors: *Agricultural chemicals, *California, *Carcinogenicity, *Legal aspects, *Public policy, *State jurisdiction, *Toxicity, *Toxicology, Drinking water, Enforcement, Labeling, Proposition 65, Regulations, Risk assessment.

In 1986, the voters of California passed a law regarding the concept of extrapolating animal toxicity data to humans. The California Safe Drinking Water and Toxic Enforcement Act of 1986, known as Proposition 65, does five things: (1) creates a list of chemicals (including a number of agricultural chemicals) known to cause cancer or reproductive toxicity; (2) limits discharge of listed chemicals to drinking water sources; (3) requires prior warning before exposure to listed chemicals by anyone in the course of doing business; (4) creates a list of chemicals requiring testing for carcinogenicity or reproductive toxicity; and (5) requires the governor to consult with qualified experts as necessary to carry out his duties. Since the definition of significant risk has not yet been established, risk assessments must be made for each substance by the state, or, if available, be obtained from federal agencies. Extensive labeling of products will probably not take place until these risk assessments have been made. Both the level of detection and the level of significant risk from exposure to carcinogens becomes extraordinarily important. Proposition 65 has a bounty law clause, stating that a person who turns in another for contaminating drinking water will receive 25% of any fine invoked. (Brunone-PTT)
W91-04008

PROSPECTS FOR INNOVATION IN WATER INSTITUTIONS: INFORMATIONAL REQUIREMENTS.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
M. L. Livingston.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 389-395, 24 ref.

Descriptors: *Competing use, *Information requirements, *Institutional constraints, *Water management, *Water use data, Conservation, Consumptive use, Economic aspects, Institutions, Political aspects, Social aspects, Water quality control, Water supply, Water use.

Competition for water supplies has created a host of new water issues: instream water use, conservation strategies, water markets, and groundwater contamination among them. It is apparent that some of the institutions governing water allocation and use are outdated. In recent years natural resource economists have expanded their research domain to address the processes and impact of institutional innovation. Considerable agreement exists on a basic theory of induced institutional innovation that is framed in terms of the demand for, and supply of, institutional change. The divergence between economic efficiency and equity goals relative to actual circumstances is important. The incentives faced by interest groups and political entrepreneurs, as well as the state of social science knowledge, are particularly relevant. Factors influencing institutional change include: the demand for institutional innovation, which arise out of the alignment, or misalignment, between social goals and actual circumstances; and, the supply of institutional innovation. A checklist of issues which are critical in evaluating a particular case might include: (1) determining the objectives of the various parties involved and whether these goals are monetary in nature; (2) what driving environmental and technical circumstances exist and whether these reflect any recent, dramatic changes in the quantity of water resources available; (3) whether there is a divergence between technically achievable and socially desirable resource use; (4) the degree to which each interested group is organized and who or what are the beneficiaries of the group; and (5) determining the cur-

rent state of social science knowledge relating to institutional impacts. (See also W91-04161) (Lantz-PTT)
W91-04203

LAND USE PRACTICES AND WATER DISPUTES.
Auburn Univ., AL. Water Resources Research Inst.
J. C. Warman, L. O. Putt, and D. H. Block.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 407-414, 7 ref.

Descriptors: *Competing use, *Land use, *Water law, *Water resources management, *Water rights, *Water use data, Alabama, Boundary disputes, Florida, Mississippi, Regulations, Riparian rights.

Historically, much of the contested use of water has had to do with land use patterns. Alabama is a typical riparian state which does not have law for conjunctive land use management. Thus, Alabama operates with policy more directed to resolution of disputes on single economic use rather than resource management. Mississippi in recent years has become a typical permit state but operates without conjunctive land use management. Classic examples are presented from current litigation in each state based on conflicts in water use that impact land use. Florida uses the critical area approach as a major instrument of regulation in conjunctive management of land and water resources. Mississippi has adopted policy but lacks the scope of Florida's regulations for conjunctive management. Examples are provided from both states of successes in management and of failures stemming from lack of coordination among local government entities that have acquired vested interests. Typically when faced with decisions among competing land owners for use of water, the judicial system has given little though to the impact on water resources. (See also W91-04161) (Author's abstract)
W91-04205

ROLE OF GOVERNMENT AGENCIES IN THE FINANCING OF WATER SUPPLY SYSTEMS.
Minnesota Univ., Duluth.
R. Vaidya, and D. J. Allee.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 425-436, 3 tab, 13 ref.

Descriptors: *Administrative agencies, *Drinking water, *Financing, *Government supports, *Water conveyance, *Water supply, *Water use data, Compliance, Institutional constraints, Regulations, Safe Drinking Water Act, Standards.

Following the passage of the Safe Drinking Water Act by Congress, the US EPA has set, in its interim primary regulations, water quality standards that all water supply systems must comply with. For the purpose of accomplishing the goals of the Act, the issue is how to balance the three program elements: regulation, the reorganization of the existing facilities, and cost sharing by government agencies. Focus is placed on the cost sharing program, in this paper, by analyzing in detail the data gathered from 800 rural water supply systems in an EPA sponsored project, to examine what could be drawn from the past experience of water supply systems in acquiring grants and loans from the state, regional and federal government agencies (such as the Farmers Home Administration). An analytic framework was developed to examine the relationship between the water system characteristics, such as the project size, the type of construction activity, the debt financing capability, and the amount of funding successfully acquired. Also, the relative importance of the system characteristics were analyzed. The policy implications of the results of analysis suggested that a water system's ability to acquire funds was dependent upon it's ability to meet the criteria set by the government agencies. (See also W91-04161) (Author's abstract)
W91-04207

WATER USE DATA REQUIREMENTS AND SOURCES FOR APPRAISAL OF WATER RIGHTS YIELDS.
Rice (Leonard) Consulting Water Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 6D.
W91-04208

EFFECTS OF IRRIGATION PUMPAGE IN NORTHWESTERN INDIANA, AND THE LEGISLATIVE PROCESS.
Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.
For primary bibliographic entry see Field 3F.
W91-04210

SPUDS FROM SPACE: USING REMOTE SENSING/GIS IN ADJUDICATING IDAHO WATER RIGHTS.
Idaho Dept. of Water Resources, Boise. Land and Water Use Data Section.
A. Morse, H. N. Anderson, and J. Peppersack.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 703-710, 2 fig, 2 tab, 8 ref.

Descriptors: *Computerized maps, *Geographic information systems, *Idaho, *Land use, *Remote sensing, *Water rights, *Water use, *Water use data, Competing use, Consumptive use, Data acquisition, Data interpretation, Databases, Landsat images, Legal aspects, Maps, Satellite technology, Statistical analysis, Water law.

The Idaho Department of Water Resources is undertaking the Nation's largest water rights adjudication project. Remote Sensing/Geographic Information System technology figure prominently in the process. Landsat satellite images are geometrically controlled, and classified to identify irrigated agriculture. The Public Land Survey System (PLSS) is being converted from a map base to a computer compatible file at quarter-quarter (QQ) section revolution. The GIS process matches the PLSS file to a classified Landsat image, and totals the irrigated acreage per QQ. Both products are designed to help water users file accurate water right claims. Regression analysis shows the average r-squared value is .91 for Landsat-computed irrigated acreage vs. acreage measured from Agricultural Stabilization and Conservation Service aerial photos of the first four counties processed. (See also W91-04161) (Author's abstract)
W91-04235

SATELLITE MANAGEMENT AND JOINT USE.
Connecticut Water Co., Clinton.
For primary bibliographic entry see Field 5F.
W91-04371

PUBLIC WATER SUPPLY DEMAND MANAGEMENT--AN ACT OF OPPRESSION.
Rhode Island Water Resources Board, Providence.
For primary bibliographic entry see Field 6D.
W91-04844

1990 FARM BILL: OPPORTUNITIES FOR GROUNDWATER PROTECTION.
Environmental and Energy Study Inst., Washington, DC.
For primary bibliographic entry see Field 5G.
W91-04859

WATER TRANSFER PROCESS AS A MANAGEMENT OPTION FOR MEETING CHANGING WATER DEMANDS.
Colorado Univ. at Boulder. Natural Resources Law Center.
L. J. MacDonnell.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274168/AS. Price codes: A22 in paper copy, A03 in microfiche. Natural Resources Law Center Research Report, April-May, 1990. Two volume report. Volume 1, 70p, 18 tab, 14 fig. Volume 2, 316p, 86 tab, 77 fig. USGS Contract No. 14-08-0001-G1538.

Descriptors: *Water demand, *Water law, *Water policy, *Water transfer, *Water use, Alternative water use, Optimum development plans, Planning, Water resources management, Water supply development.

The West is in transition from an era of water supply development to a period of reallocation of a portion of the developed supplies to new uses. One important reallocation option is the use of water transfers--transactions involving a voluntary change in the purpose and/or place of water under an existing water use entitlement. This study examines the water transfer law and experience in six western states: Arizona, California, Colorado, New Mexico, Utah and Wyoming. Volume one provides a general summary of the findings from the study. It includes economic and demographic comparisons among the states including comparisons in water use. It provides a comparative analysis of the level and types of transfers in the study states based on an analysis of all applications for water transfer submitted for state review between 1975 and 1984. It also offers general recommendations for facilitating water transfers. Volume two contains the detailed findings from the individual state studies. Included are analyses of the laws and procedures governing transfer in the states as well as of the transfer activity during the study period. Conclusions and recommendations specific to each state are presented. (USGS)
W91-04886

6F. Nonstructural Alternatives

RESOURCE MANAGEMENT TO ACCOMMODATE MULTIPLE USE OF STREAMFLOW IN THE RIO CHAMA, NEW MEXICO.
Bureau of Reclamation, Albuquerque, NM. Water Accounting and Reservoir Regulation Branch.
For primary bibliographic entry see Field 6D.
W91-04216

FRAMEWORK FOR RESHAPING WATER MANAGEMENT.
Florida Univ., Gainesville. Coll. of Engineering.
For primary bibliographic entry see Field 6B.
W91-04555

6G. Ecologic Impact Of Water Development

FOOD PRODUCTION, ENVIRONMENTAL PROTECTION, AND HEALTH EFFECTS IN MEXICAN AGRICULTURE.
Institute for the Development of Occupational Safety and Health, Toluca (Mexico).
F. Lopez de Alba.
American Journal of Industrial Medicine AJIMD8, Vol. 18, No. 4, p 495-498, 1990.

Descriptors: *Agriculture, *Crop production, *Environmental protection, *Mexico, *Population exposure, *Public health, *Water pollution control, Education, Fate of pollutants, Hazardous materials, Herbicides, Human population, Insecticides, Public opinion, Regulations.

In countries like Mexico, where the need to increase agricultural productivity to satisfy an ever-increasing population is great, attention to environmental problems is recent. However, current public concern has forced the administration to consider environmental protection as a key strategy in the development model. The use of insecticides and herbicides is an increasing problem, influenced by several factors: toxicity of the applied compound; weather conditions; toxicity of the breakdown products of the applied pesticide; and direct contact between pesticide and workers. In countries like Mexico, where winter crops account for about one third of the total vegetable imports of the United States, agricultural production methods and pesticide formulations have been modified in response to U.S. regulations. However, use of banned pesticides is quite common for crops consumed within Mexico. Applicators often wear no

protective gear, and there is lack of knowledge about pesticide management. A high frequency of spraying results in the concurrent increased risk of pesticide hazards and the nullification of the advantages of rapid degradation of the chemicals involved. In 1988, a new law of the environment was passed, which contains a listing of pesticides, and creates an extensive training program for producers and users of agricultural pesticides. (Brunone-PTT)
W91-04009

EFFECTS OF SALINITY ON RIVER, STREAM AND WETLAND ECOSYSTEMS IN VICTORIA, AUSTRALIA.
Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.
For primary bibliographic entry see Field 5C.
W91-04040

ZOOGEOGRAPHICAL RELATIONSHIPS OF AQUATIC INSECTS (EPHEMEROPTERA, PLECOPTERA, AND TRICOPTERA) FROM THE EASTERN JAMES BAY DRAINAGE.
Montreal Univ. (Quebec). Dept. of Biological Sciences.
P. P. Harper.
Canadian Field-Naturalist CAFNAK, Vol. 103, No. 4, p 535-546, October/December 1989. 3 fig, 2 tab, 37 ref.

Descriptors: *Aquatic insects, *Baseline studies, *Canada, *Hydroelectric power, *Zoogeography, Caddisflies, Environmental impact, Mayflies, Species composition, Stoneflies.

An analysis of the aquatic insect fauna of the eastern James Bay drainage was conducted on the basis of specimens assembled in 1973-1982 during several impact studies related to the major hydroelectric projects conducted in the area. 220 species were collected in the orders Plecoptera (22), Ephemeroptera (50), and Trichoptera (148). The faunistic elements recognized included the Holarctic (16 species), the northern transcontinental (42), the continental (28), the central (1) various eastern (113), and the Appalachian (14) elements. Endemism (2 species) is probably only apparent, and the two species are likely to belong to wider ranging assemblages. The arctic element was totally lacking. Two main pathways for colonization are suggested, one from Northwestern refugia and another from Southern refugia, probably through the Mississippi-St. Lawrence waterways. Dispersal appears to have been greatest in Tricoptera and least in Plecoptera; respective importances of the transcontinental fauna varied from 14% (Plecoptera) to 47.3% (Tricoptera), while the eastern fauna represented from 47.3% in the Tricoptera to 71% in the Plecoptera. Comparisons with six Northeastern sites showed a high similarity (80% in Tricoptera) with two sites at corresponding latitudes, but only a moderate (less than 50%) similarity with more southerly sites (46-47 degrees north). Though the fauna has few original elements, its peculiarity resides in its species composition and its position at the entry point for western boreal elements into the Quebec-Labrador Peninsula. (Author's abstract)
W91-04057

PINTAIL, ANAS ACUTA, USE OF MAN-MADE PONDS IN QUEBEC.
Quebec Univ., Trois-Rivieres. Dept. de Chimie-Biologie.
L. Belanger, and R. Couture.
Canadian Field-Naturalist CAFNAK, Vol. 103, No. 4, p 547-550, October/December 1989. 1 tab, 19 ref.

Descriptors: *Artificial ponds, *Ducks, *Environmental effects, *Sandpits, *Wastewater lagoons, Distribution patterns, Ecological distribution, Quebec, Waterfowl, Wildlife habitats.

Four types of man-made ponds in south-central Quebec--annular, excavated, sewage, and sand-pit ponds--were surveyed for waterfowl utilization. These ponds were used by seven dabbling duck species of which the northern pintail (Anas acuta) was the most common, using all pond types studied. Mean pintail brood density was 0.68/ha, with a maximum brood use of 2.7/ha at sewage ponds. Species that expanded their breeding ranges eastward during last decades like the mallard (Anas platyrhynnchos) and the gadwall (Anas strepera) also made appreciable use of the man-made ponds (combined mean of 0.1 brood/ha). Sewage ponds were the only type used by all duck species censused. However, the study ponds were unattractive to broods of northeastern species such as the wood duck (Aix sponsa) or the black duck (Anas rubripes). The creation in eastern North America of potentially productive breeding habitats (farm ponds, agricultural ditches, sewage ponds, etc.), which are unattractive or inadequate for northeastern species, may have favored the invasion of prairie duck species. (Fleishman-PTT)
W91-04058

ADVECTION OF EUPHAUSIIDS IN A NORWEGIAN FJORD SYSTEM SUBJECT TO ALTERED FRESHWATER INPUT BY HYDROELECTRIC POWER PRODUCTION.
Bergen Univ. (Norway). Dept. of Fisheries and Marine Biology.
S. Kaartvedt, and H. Svendsen.
Journal of Plankton Research JPLRD9, Vol. 12, No. 6, p 1263-1277, November 1990. 7 fig, 2 tab, 28 ref.

Descriptors: *Estuarine environment, *Fjords, *Hydroelectric plants, *Limnology, *Norway, *Saline-freshwater interfaces, Biological studies, Ecosystems, Environmental impact, Freshwater, Runoff, Water circulation, Water currents.

Hydroelectric power production alters freshwater runoff patterns to marine ecosystems, and thus physical properties of the upper layers, which in turn affects numerous biological properties. To evaluate the impacts of modified freshwater discharge, a research program was carried out in a fjord system of western Norway. It was found that, due to hydroelectric power production, the freshwater input to the Sandsfjord system has increased during winter, while the freshwater input to Josenfjorden has been removed. In autumn and winter both Meganyctiphanes norvegica and Thysanoessa raschii were most common in Josenfjorden, and T. raschii was scarce in the Sandsfjord system. The euphausiids generally swam to the surface layer at night, but avoided low salinity water in the upper layers of the Sandsfjord system. Still, in most locations, approximately 50% of M. norvegica was found in the upper 10 m. Their vertical distribution overlapped with freshwater-driven currents, and estuarine circulation apparently governed the horizontal distribution within the Sandsfjord system. At the entrance to the fjord, M. norvegica was distributed deeper than within the fjord, reducing the importance of estuarine circulation relative to currents driven by wind at the coast. Estimates of advective rates of M. norvegica suggest that exchange with coastal waters was more important for the standing stock than local growth within the fjords. In Josenfjorden, maxima of T. raschii were always found in a zone of shallowing bottom topography (bottom depth approximately 130 m), where this species possibly maintained its horizontal position by means of vertical migrations. (Author's abstract)
W91-04112

EFFECTS OF REGIONAL GROUND-WATER LEVEL DECLINES ON STREAMFLOW IN THE OKLAHOMA PANHANDLE.
Geological Survey, Lakewood, CO. Water Resources Div.
K. L. Wahl, and T. L. Wahl.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 239-249, 4 fig, 2 tab, 22 ref.

Descriptors: *Groundwater level, *Groundwater mining, *Streamflow, *Surface-groundwater relations, *Water resources development, *Water use data, Aquifers, Base flow, Beaver River, Environmental effects, Flow discharge, Hydrologic budget, Oklahoma, Pumping, Wells.

Increased pumping from the High Plains aquifer has resulted in widespread water level declines in the aquifer. Declines of 25 to 50 feet are common in western Oklahoma; south of Guymon, water levels have declined about 100 feet. The number of large capacity wells (primarily irrigation wells) in the Oklahoma Panhandle increased from about 450 in 1963 to about 2,500 in 1984. The Beaver River drains most of the Oklahoma Panhandle and has been gaged near Guymon since 1937. Although changes in the use of surface water have been minimal during this period, trend tests confirm that the discharge of the river has decreased substantially. There has been no corresponding change in precipitation. Average annual discharge at Guymon for 23 years through 1960 was 32.2 cu ft/s; the average annual discharge for the last ten years (1977-86) has been about 7 cu ft/s. Prior to the mid-1960s, the river at Guymon was generally perennial; flow ceased only during droughts and then never for more than 60 days in any given year. Since 1968, the river at Guymon has been dry for extended periods every year and presently (1988) averages about 300 days of no flow per year. (See also W91-04161) (Author's abstract)
W91-04189

VIRGIN RIVER: PLANNING FOR DEVELOPMENT WHILE MEETING FLOW REQUIREMENTS FOR ENDANGERED SPECIES.
Utah Dept. of Natural Resources, Salt Lake City. Div. of Water Resources.
For primary bibliographic entry see Field 6D.
W91-04217

GROUND WATER, GEOMORPHIC PROCESSES, AND RIPARIAN VALUES: SAN PEDRO RIVER, ARIZONA.
Bureau of Land Management, Phoenix, AZ. Arizona State Office.
D. McGlothlin, W. L. Jackson, and P. Summers.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 537-545, 4 fig, 13 ref.

Descriptors: *Groundwater availability, *Groundwater mining, *Riparian land, *San Pedro River, *Streamflow, *Surface-groundwater relations, *Water resources development, *Water use data, Aquifers, Arizona, Channel morphology, Geomorphology, Groundwater budget, Riparian vegetation, Sedimentation, Water table fluctuations.

The unique natural character of the upper San Pedro River is inextricably linked to the regional basin-fill aquifer and to ongoing geomorphic processes in the riparian zone. Riparian vegetation, wildlife, fisheries, recreation, and other water-related natural values depend on instream flows (including floods and related groundwater conditions). Base flow and the water table beneath the riparian zone are maintained almost entirely by inflow from the regional basin-fill aquifer. Regional groundwater depletions or localized drawdowns in the floodplain aquifer can decrease instream flows and concurrently lower the water table beneath the riparian zone. The cottonwood stands along the San Pedro River are especially sensitive to water table declines. Periodic flood flows are required for vegetation reproduction, floodplain development, and channel maintenance and evolution. Preservation and future management of the outstanding riparian resource along the river will be predicated on the successful basin-wide management of the regional groundwater resource and on the continued morphologic evolution associated with ongoing channel adjustments and sedimentation processes. (See also W91-04161) (Author's abstract)
W91-04218

WATER TRANSFERS IN ARIZONA: ASSESSING THE ADVERSE EFFECTS ON AREAS OF ORIGIN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 6D.
W91-04219

NATURAL CONSUMPTIVE USE BY TULES, GRASSLANDS, AND RIPARIAN FORESTS, CALIFORNIA CENTRAL VALLEY.
For primary bibliographic entry see Field 2I.
W91-04227

NATURAL RESOURCE ACCOUNTING SYSTEMS AND ENVIRONMENTAL POLICY MODELING.
New Mexico State Univ., Las Cruces. Dept. of Economics.
For primary bibliographic entry see Field 6B.
W91-04563

STREAM GEOMORPHOLOGY: EFFECTS ON PERIPHYTON STANDING CROP AND PRIMARY PRODUCTION.
New Mexico Univ., Albuquerque. Dept. of Biology.
R. L. Coleman, and C. N. Dahm.
Journal of the North American Benthological Society JNASEC, Vol. 9, No. 4, p 293-302, December 1990. 6 fig, 2 tab, 50 ref.

Descriptors: *Beavers, *Channel morphology, *Environmental effects, *Periphyton, *Primary productivity, Algal growth, Chlorophyll a, Detritus, Limiting nutrients, Nitrogen, Organic matter.

Significant losses of retentive structures from many small streams have resulted from beaver trapping. The algal standing crops and rates of primary production were compared in two adjacent streams in the Zuni Mountains of New Mexico. Castor Creek has been worked by beaver and is a complex, highly retentive system with an extensive floodplain and accumulations of organic debris. Sawmill Creek is moderately incised, free of large organic debris, and poorly retentive. Clay tiles introduced into Castor Creek had average chlorophyll a standing crops 3 to 9 times greater than Sawmill Creek (54.8-257.8 vs. 18.4-44.9 mg/sq m). Chlorophyll a on natural substrates averaged 11 times greater in Castor Creek than in Sawmill Creek (1679.4 vs. 154.2 mg/sq m). Average standing crop of chlorophyll a per 250 m reach was 136 times greater in Castor Creek than in Sawmill Creek due to its greater surface area (12.4 times) and greater standing crop (11 times). Extensive filamentous algal mats and the macro-alga Nitella gracilis in Castor Creek's beaver ponds exhibited the highest rates of primary production (85 mg C/sq m/hr) while epilithic samples from both streams were similar (16.6 and 21.2 mg C/sqm/hr for Castor and Sawmill Creeks, respectively). Nutrient amendment experiments revealed that both streams were nitrogen limited. Sediment samples taken in 1989 showed Castor Creek had 25 times more dissolved NH4 in the upper 5 cm of sediment than Sawmill Creek (1242 vs. 50 micrograms/L). It is suggested that higher algal production in Castor Creek is linked to greater nutrient availability at the sediment/water interface due to greater retention and processing of organic matter in the hyporheic zone. (Author's abstract)
W91-04714

SEASONAL DYNAMICS AND PRODUCTION OF CHIRONOMIDAE IN A LARGE LOWLAND RIVER UPSTREAM AND DOWNSTREAM FROM A NEW RESERVOIR IN CENTRAL POLAND.
Lodz Univ. (Poland). Dept. of Ecology and Vertebrate Zoology.
For primary bibliographic entry see Field 2H.
W91-04739

DOWNSTREAM EFFECTS OF A SMALL IMPOUNDMENT ON A TURBID RIVER.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
R. W. Palmer, and J. H. O'Keefe.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 4, p 457-473, October 1990. 4 fig, 4 tab, 45 ref.

Descriptors: *Benthos, *Dam effects, *Invertebrates, *Reservoir releases, *Rivers, *Species composition, Ammonia, Chlorophyll a, Ecological effects, Environmental effects, Fishkill, Population density, Reservoirs, Suspended solids, Turbidity.

Physicochemical parameters were measured and riffle-dwelling benthic invertebrates were sampled over a one year period at three locations upstream and seven locations downstream of a small impoundment (244 ha) on a turbid river. Physical and chemical conditions and the benthic invertebrate communities differed upstream and downstream of the impoundment. Surface-released water contained high levels of chlorophyll-a, and low concentrations of suspended material compared to inflowing water, while bottom-released water contained low levels of chlorophyll-a and high concentrations of ammonia. Typical taxa upstream of the impoundment included Ephemeroptera, hydropsychid Trichoptera, Chironomidae, Nematoda and the pest blackfly, Simulium chutteri. Immediately downstream of the dam the numbers of benthic invertebrates were generally fewer than upstream, and typical taxa included Chironomidae, Hydra, Oligochaeta, and non-pest species of blackfly. Conditions took between 25 to 86 km to recover to above-impoundment levels. Draining of the reservoir released water with high concentrations of suspended material (2,829 mg/L), caused fish kills for 3.5 km downstream, and depleted benthic invertebrate population densities for over 200 km downstream, the latter recovering within 2 months. It is recommended that releases from the reservoir should aim to simulate natural flow conditions, and in doing so, create conditions which are unsuitable for the pest blackfly, S. chutteri. (Author's abstract)
W91-04740

HABITAT ALTERATION AND ITS EFFECTS ON NATIVE FISHES IN THE UPPER TENNESSEE RIVER SYSTEM, EAST-CENTRAL U.S.A.
Virginia Cooperative Fish and Wildlife Research Unit, Blacksburg.
R. J. Neves, and P. L. Angermeier.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 45-52, 1990. 1 fig, 1 tab, 14 ref.

Descriptors: *Aquatic habitats, *Environmental effects, *Fish behavior, *Fish conservation, *Fish populations, *Species diversity, *Tennessee River, Agriculture, Effluents, Mining, Regulations, Tailwater, Toxicity, Water pollution effects.

The upper Tennessee River drainage, which includes portions of the states of Virginia, North Carolina, and Tennessee, supports an exceptionally diverse fish fauna. Recent reductions in abundance and geographic ranges of several freshwater fishes have promulgated the imposition of protective measures for about 115 species among the three states, with nearly half of those species occurring in the upper Tennessee River. Most protected species are darters (Percidae: Etheostomatinae) or minnows (Cyprinidae), and are typically small, benthic invertivores. Major impacts on the fish fauna have resulted from dams, introduced species, toxic spills, mining and agriculture. An important cumulative effect of these impacts is fragmentation of the watershed; nearly 40% of the riverine habitat in major tributaries is either impounded or altered by tailwater discharges. The isolation and stress imposed on tributaries of the river have caused and will continue to cause extirpations of fishes, mussels and other aquatic fauna. Numerous federal, state and private organizations are cooperating in efforts to protect rare species and habitats, improve agricultural and coal-producing practices, and enforce regulations for industrial and municipal effluents. (Author's abstract)
W91-04783

CONSERVATION STATUS OF THE NORTH AMERICAN FISH FAUNA IN FRESH WATER.
Bureau of Land Management, Washington, DC. Wildlife and Fisheries Div.
J. E. Williams, and R. R. Miller.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 79-85, 1990. 1 fig, 1 tab, 14 ref, append.

Descriptors: *Canada, *Conservation status, *Ecosystems, *Fish conservation, *Mexico, *Regulations, *Species diversity, *Water resources management, Dam construction, Endangered species, Fish management, Fish populations, Genetics, Resource management.

The status of the North American fish fauna includes 292 species of fishes in the categories of endangered, vulnerable, rare, indeterminate, and extinct. This constitutes 28% of the known fauna. The status of fishes and their habitats continues to decline, especially in the arid regions of western USA and northern Mexico. Government water policies in the west have favored construction of dams and water delivery systems at the expense of free-flowing rivers and natural fish communities. The Endangered Species Act is the most powerful tool currently available in the United States to protect rare fishes. Canada and Mexico lack powerful species conservation legislation. While many fishes probably have been saved from extinction by this Act, surprisingly few have improved enough to be removed from under its protection. To improve conservation strategies, natural history studies should be increased to monitor native fish populations, to identify areas under increasing threat, and to identify habitats containing large numbers of vanishing fishes. In all countries, programs of genetic and ecological studies are needed to manage endangered fishes. Legislation should be developed and implemented, and funding and staff should be increased. A conservation strategy should be developed to protect remaining natural communities that support a relatively intact fish fauna. Finally, in North American countries, policies should be developed to stabilize human population growth and reduce resource consumption. (Brunone-PTT)
W91-04785

CONSERVATION AND STATUS OF THREATENED FISHES IN SOUTHERN AFRICA.
J.L.B. Smith Inst. of Ichthyology, Grahamstown (South Africa).
P. H. Skelton.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 87-95, 1990. 2 fig, 1 tab, 16 ref.

Descriptors: *Endangered species, *Environmental effects, *Fish conservation, *Introduced species, *South Africa, *Species diversity, Aquatic habitats, Climatic effects, Conservation, Ecological effects, Estuaries, Geographic distribution, Water resources management.

The conservation status of 24 threatened freshwater fishes and seven estuarine fishes from southern Africa is outlined against the background of natural and anthropogenic environmental factors. The majority of threatened species are endemic temperate forms with restricted ranges. Major threats include introduced alien fishes and a wide spectrum of environmentally destructive causes. Research on threatened species includes distribution surveys, biological and ecological studies and methods of artificial propagation. Long-term remedies based on ecosystem conservation are also being promoted. The perceptions and attitudes of nature conservation authorities are adjusting to the new challenges of fish conservation. Water is a limiting resource in most of southern Africa and for much of Africa as well. Ecological pressures are frequently exacerbated by adverse climatological and sociological conditions. The number of threatened fishes in Africa is likely to increase in the face of escalating problems of habitat destruction and degradation. (Author's abstract)
W91-04786

IMPACT OF DAMMING, DROUGHT AND OVER-EXPLOITATION ON THE CONSERVATION OF MARKETABLE FISH STOCKS OF THE RIVER BENUE, NIGERIA.
Portsmouth Polytechnic (England). Centre for Marine Resources Economics.
A. E. Neiland, J. P. Goddard, and G. M. Reid.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 203-205, 1990. 1 tab, 5 ref.

Descriptors: *Benue River, *Climatic changes, *Dam effects, *Drought effects, *Fish conservation, *Nigeria, *River fisheries, *Water resources management, Aquatic habitats, Fish behavior, Fish physiology, Flow discharge rates, Oxygen requirements, Productivity, Species diversity, Succession, Temperature effects.

About 20 years ago the River Benue, a major tributary of the Niger in Nigeria, supported a large and ichthyologically diverse artisanal fishery. A marked change in the taxonomic composition of the fishery is now evident from recent field observations. Ostariophysan fishes, once dominant in the market, have been replaced by other groups. Tilapine cichlids and clariid catfish are now 34% and 14%, respectively, of total landings. Support for the observed changes in market composition over times comes from calculation of the Herfindahl index of diversity, derived from the sum of squares of the relative contribution of each genus. Three main parameters determine market fish supply: consumer demand, fishing intensity, and the availability of wild stocks. Market composition of catches must reflect the natural riverine fish community structure and productivity. The fishery shows an increase in some piscivores, zooplanktivores, and other predators relative to herbivores and detritivores. An overall ecophysiological shift of taxa known to be tolerant of reduced water flow, high ambient temperature, low dissolved oxygen and capable of prolific precocious breeding. The increase in Sahelian drought conditions over the last fifteen years, plus a dam constructed in 1986, may be factors responsible for dramatic fish population and ecotype changes taking place. Over-exploitation, using non-selective nylon gillnets, is another variable evidently important in determining the population status of River Benue fishes. In addition, with a rapid rise in human population, the Nigerian market demand for fish has risen to a level where fisherman can now easily sell their entire catch. The dynamic interrelationships between exploitation patterns, market economics, environmental change and fishery production are, however, still poorly understood. (Brunone-PTT)
W91-04790

RARE AND ENDANGERED FISHES FROM YUGOSLAVIAN ADRIATIC RIVERS.
Fisheries Research Inst., Ljubljana (Yugoslavia).
M. Povz, S. Leiner, M. Mrakovic, and J. Popovic.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 247-249, 1990. 1 tab, 2 ref.

Descriptors: *Aquatic habitats, *Endangered species, *Environmental effects, *Fish conservation, *Hydroelectric power, *Rivers, *Yugoslavia, Conservation, Drinking water, Endemism, Fishing, Path of pollutants, Species diversity, Water pollution effects, Water resources management.

About thirty endemic species and subspecies of fish live in rivers of the Adriatic basin. Most of them fall into the category of threatened fish. The Adriatic rivers are very short but steep and are suitable for hydroelectric generating stations; a number of these have been built, causing major changes to habitats of the native species of fish. The endemic fish species and subspecies of the Adriatic basin are threatened by the following major impacts: changes in habitat due to building hydroelectric dams and reservoirs; exploitation of water sources for drinking water, pollution of the rivers and coastal tracts; introduction of alien species of fish, resulting in hybridization and interspecific competition with native species; uncontrolled and excessive fishing for all species and sizes. Currently, nature conservation measures are not being taken, except in the north Adriatic River Soca where fish are legally protected through a closed season and minimum length of fish, and some are propagated artificially. All subspecies of the genus Salmothymus are seriously threatened and so are numerous other genera and species. The protection of endemic species and subspecies is necessary although the nature of the measures required is often controversial, such as stopping the building of power stations on rivers. (Author's abstract)
W91-04795

GROUND-WATER PUMPAGE AND WATER-LEVEL DECLINES IN THE PEEDEE AND BLACK CREEK AQUIFERS IN ONSLOW AND JONES COUNTIES, NORTH CAROLINA, 1900-86.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04901

7. RESOURCES DATA

7A. Network Design

SAMPLING NETWORK DESIGN FOR TRANSPORT PARAMETER IDENTIFICATION.
California Univ., Los Angeles. Dept. of Civil Engineering.
T. G. Cleveland, and W. W.-G. Yeh.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 764-783, November/December 1990. 6 fig, 6 tab, 25 ref. USGS Award 14-08-0001-G1499.

Descriptors: *Groundwater transport, *Network design, *Sampling, *Water pollution control, Decision making, Environmental protection, Groundwater, Mathematical models, Sensitivity analysis, Tracers.

Awareness of environmental quality and the desire to control pollution have resulted in the need to predict the movement of groundwater and pollutants carried by the water. Mathematical models are used to predict the response of a groundwater system to various management policies. Estimation of the parameters used in these models is a critical step in their operation, and ultimately in the management decisions that are made. An optimal experiment design algorithm was developed to facilitate the planning and optimal configuration and scheduling of a groundwater tracer test whose data are to be used to estimate model parameters. A maximal information criterion is used to select among competing designs. The proposed criterion is equivalent to a weighted sum of squared sensitivities, employing the observation that parameters are most accurately estimated at points with high sensitivity to the parameter but that the relative magnitudes of sensitivities to different parameters are different. The fundamental advantage of this criterion is that it is comparatively simple. The influence-coefficient method is used to compute the sensitivity coefficient. A zero-one integer heuristic is used to solve a simplified example for experiment configurations under a given experimental duration. The design considers the installation cost, which is a function of location and depth of the observation well and of the samples themselves. A dramatic increase in information can be obtained with an experimental budget increase. (Author's abstract)
W91-03991

OPTIMAL UPGRADING OF HYDRAULIC-NETWORK RELIABILITY.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W91-03992

INVESTIGATION OF THE ALLOCATION OF SAMPLING STATIONS DURING ESTUARINE SURVEYS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
D. Jiang, D. J. Elliot, and A. James.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 337-348, 3 fig, 1 tab, 10 ref.

Descriptors: *Estuaries, *Kriging, *Monitoring, *Network design, *Sampling, *Statistical methods, *Water quality, *Water sampling, *Water use data, Data acquisition, Dissolved oxygen, England, Flow rates, Salinity, Surveys, Tees River Estuary, Temperature.

The generalized kriging method has been applied to the analysis of sampling stations in the partially mixed estuary of the River Tees. Although many surveys have been carried out on the estuary, little attention has been paid to: (1) how many sampling stations must be used; and (2) how the sampling stations should be positioned. A unique characteristic of kriging is that it not only gives an explanation but provides a magnitude of estimation error. The sets of data analyzed were from the 1975 survey of the Tees Estuary. The procedure of overall variance can yield both logical and reasonable indications of the relative significance of each sampling station. The procedure of re-estimation is employed in order to determine which sampling stations could be reproduced by other remaining stations. It was concluded that salinity and temperature can be measured with fewer stations, but more sampling stations are needed if more accurate estimations are required for velocity and dissolved oxygen. (See also W91-04161) (Author's abstract)
W91-04198

ENVIRONMENTAL RESEARCH FIELD SITE 'HORKHEIMER INSEL': RESEARCH PROGRAM, INSTRUMENTATION AND FIRST RESULTS.
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
G. Teutsch, and H. Kobus.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 491-501, 1990. 8 fig, 2 tab, 4 ref.

Descriptors: *Data acquisition, *Field tests, *Groundwater, *Observation wells, *On-site investigations, *Soil water, Agricultural practices, Databases, Denitrification, Germany, Horkheimer Insel, Interdisciplinary studies, Lysimeters.

In order to carry out soil and groundwater related field experiments under controlled natural conditions, an environmental research test site has been set up in July 1987 on the 'Horkheimer Insel', 70 km north of Stuttgart. At present, the interdisciplinary research program comprises one groundwater project, two projects dealing with the unsaturated zone and the soil, and one environmental database project. The 2 ha field site is extensively instrumented, comprising 24 multilevel groundwater observation and pumping wells, a large monolithic lysimeter, a meteorological station, as well as numerous tensiometer and suction cups. In order to facilitate the communication and data exchange between the cooperating university institutes, a distributed database system is being developed. During the initial phase of the investigations, the field site has been extensively described in terms of underground structure, as well as the soil and aquifer parameters. Preliminary results indicated that peak nitrogen concentrations were seven times higher underneath a field farmed by conventional techniques compared to a field farmed using lower quantities of agricultural chemicals and reduced tillage (sustainable field). Corn yields were 7600 kg/ha for the conventional field and 7200 kg/ha for the sustainable field. Increased bicarbonate and sulfate concentrations give strong evidence for significant denitrification beneath the sustainable field and grassland. Parallel to the field work, a number of mathematical models for the simulation of crop growth, unsaturated flow, as well as nitrate and pesticide transport are being developed. (MacKeen-PTT)
W91-04308

SMALL TIME AND SPACE MEASUREMENTS OF THE MEAN RAINFALL RATE MADE BY A GAGE NETWORK AND BY A DUAL-POLARIZATION RADAR.
Observatoire de Physique du Globe de Clermont-Ferrand (France).
M. Messaoud, and Y. B. Pointin.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 9, p 830-841, September 1990. 10 fig, 2 tab, 30 ref. French Ministere de la Recherche et de la Technologie Contract 84F0497.

Descriptors: *France, *Meteorology, *Network design, *Radar, *Rain gages, *Rainfall distribution, *Rainfall rate, *Remote sensing, *Urban hydrology, Correlation analysis, Differential reflectivity, Performance evaluation, Spatial distribution, Temporal distribution.

Small time (1-15 min) and space (0.5-1.5 km) measurements of the mean rainfall rate were made within 10 km of a dual-polarization radar during

several widespread or convective precipitation events in the vicinity of Clermont-Ferrand (France). The time and space characteristic scales of the gage and of the radar data were evaluated to find the minimum time interval and spatial resolution for with the mean rainfall rate values had a large enough statistical significance. Then quantitative comparisons were made between the mean rainfall rate deduced from the gage data and that deduced from the radar measurements, with or without using differential reflectivity values. The correlation between the values obtained from gages and those derived from radar data without using differential reflectivity values is 0.7 when the mean rainfall rate values are large and when the radar time coverage exceeds 50%. In this case, the use of differential reflectivity values appeared to improve the estimation of mean rainfall field for small time intervals. For time intervals of an hour or more this improvement appears to be relatively less important because the small-scale inhomogeneities are smoothed out by the averaging process. (Rochester-PTT)
W91-04431

FREQUENCY-WAVENUMBER SPECTRUM FOR GATE PHASE I RAINFIELDS.
Texas A and M Univ., College Station. Coll. of Geosciences.
For primary bibliographic entry see Field 2B.
W91-04432

THREE COMPUTERIZED, STRATIFIED RANDOM SITE-SELECTION METHODS FOR DESIGN OF A GROUND-WATER-QUALITY SAMPLING NETWORK.
Geological Survey, Oklahoma City, OK. Water Resources Div.
J. C. Scott.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4101, 1990. 109p, 15 fig, 4 tab, 20 ref.

Descriptors: *Computer programs, *Groundwater quality, *Network design, *Sampling, *Site selection, *Statistical methods, *Water quality.

Computer software was written to randomly select sites for a groundwater-quality sampling network. The software uses digital cartographic techniques and subroutines from a proprietary geographic information system. The report presents the methods, computer software, and sample applications. It is often desirable to collect groundwater-quality samples from various areas in a study region that have different values of a spatial characteristic, such as land use or hydrogeologic setting. A stratified network can be used for testing hypotheses about relations between spatial characteristics and water quality, or for calculating statistical descriptions of water quality data that account for variations that correspond to the spatial characteristic. In the software described, a study region is subdivided into areal subsets that have a common spatial characteristic to stratify the population into several categories from which sampling sites are selected. Different numbers of sites may be selected from each category of areal subsets. A population of potential sampling sites may be defined by either specifying a fixed population of existing sites, or by preparing an equally spaced population of potential sites. In either case, each site is identified with a single category, depending on the value of the spatial characteristic of the areal subset in which the site is located. Sites are selected from one category at a time. One of two approaches may be used to select sites. Sites may be selected randomly, or the areal subsets in the category can be grouped into cells and sites selected randomly from each cell. (USGS)
W91-04470

PLAN OF STUDY FOR SELECTED TOXIC SUBSTANCES IN THE CALCASIEU RIVER, LOUISIANA.
Geological Survey, Baton Rouge, LA.
For primary bibliographic entry see Field 5B.
W91-04637

TAXONOMIC LEVEL AND SAMPLE SIZE SUFFICIENT FOR ASSESSING POLLUTION IMPACTS ON THE SOUTHERN CALIFORNIA BIGHT MACROBENTHOS.
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.
For primary bibliographic entry see Field 5C.
W91-04721

7B. Data Acquisition

X-BAND SCATTEROMETRY IN AGRICULTURE.
Budapesti Mueszaki Egyetem (Hungary). Dept. of Microwave Telecommunications.
S. Mihaly, and I. Bozoski.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1287-1290. 5 fig, 2 tab, 5 ref. OMFB Committee of Technical Help, Hungary, Contract No. 7-12-0127.

Descriptors: *Data acquisition, *Hungary, *Microwaves, *Remote sensing, *Scatterometry, *Soil moisture, Instrumentation, Measuring instruments.

In the field of active microwave remote sensing scatterometry is a widely used method to get data samples of backscattering properties of various objects, fields, soils, vegetation, etc. Bare soil backscattering measurements using an X-band scatterometer were taken in May-July 1987 at the VITUKI Research Centre for Water Resources Development. The instrument was a new mobile FM/CW scatterometer with flat microstrip cross-polarized antenna and automated data collecting and processing facilities. Measurements were taken at 10.3 GHz at H and V like polarization are interpreted with insitu gravimetric and pF soil moisture data. Surface roughness and temperature are also measured insitu. The test setup consisted of a calibrating corner reflector, five soil moisture and temperature measuring kits distributed over the test field, and a surface roughness kit. The ten day data series was grouped into three subgroups according to the gravimetric moisture content in the top 0-2 cm layer of the soil. Evaluation of the surface roughness measurement has shown that the roughness in terms of the standard deviation of the surface height is in the range of a quarter of the wavelength. Averaging of the backscattering data over the measured values of each moisture group show that general dependence upon the incidence angle in the range of 15-40 degrees is the expected decreasing function with increasing incidence angle measured from vertical. The dynamic range is about 7 dB. (See also W91-03944) (Tappert-PTT)
W91-03945

CORRELATION OF REFLECTANCE AND CHLOROPHYLL FLUORESCENCE SIGNATURES OF HEALTHY AND DAMAGED FOREST TREES.
Karlsruhe Univ. (Germany, F.R.). Botanisches Inst. II.
C. Buschmann, and H. K. Lichtenthaler.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1339-1342. 4 fig, 8 ref.

Descriptors: *Chlorophyll, *Fluorescence, *Forest hydrology, *Forestry, *Instrumentation, *Measuring instruments, *Remote sensing, Data acquisition, Leaves, Water stress.

Airborne forest inventory and tree damage classification by remote sensing is mainly based upon reflectance signatures in the visible and near-infrared. In the past two years difficulties in the classification of tree damage by airborne forest inventory have arisen as the reflectance signature of damaged trees with low physiological activity no longer showed the expected decrease of the reflectance signal in the 800 nm region. A new measuring system was established using white light (VIRAF-spectrometer), which makes it possible to detect absorption spectra, fluorescence emission spectra, and Kautsky induction kinetics parallel to the reflection spectra without changing the position of the leaf sample. These additional measurements characterize the physiological activity of one leaf sample, which can be left intact and attached to the plant. Needles were collected from healthy and damaged spruce trees in the northern Black Forest at an altitude of 450-700 m above sea level. Beech leaves were collected from the botanical garden of the University of Karlsruhe. Leaves of a healthy, well-watered tree were compared to leaves of a tree subjected to water stress. The reflectance spectra of damaged trees are characterized by an increase in the reflectance signal in the visible range. The absorption spectrum of the leaves developed under water stress indicates the lower light scattering properties due to the lower water content of the leaf tissue and a lower chlorophyll content. The new measuring system will permit a better interpretation of remotely sensed reflection signatures and can improve forest classification and agricultural field studies. (See also W91-03944) (Tappert-PTT)
W91-03946

CORRELATION OF RADAR REFLECTIVITY AND CHLOROPHYLL FLUORESCENCE OF FOREST TREES.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Elektrotechnische Gundlagen der Informatik.
U. Rinderle, M. Haitz, H. K. Lichtenthaler, D. H. Kahny, and Z. Shi.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1343-1346. 5 fig, 1 tab, 8 ref.

Descriptors: *Chlorophyll, *Fluorescence, *Forestry, *Plant physiology, *Radar, *Remote sensing, Data acquisition, Instrumentation, Water stress.

Forest damage classification by remote sensing has hitherto mainly relied upon the optical reflectance signatures of trees measured in the visible and near-infrared region. High resolution, wide-band complex polarimetric Radar Cross Section (RCS) measurements of cut-off twigs and leaves of forest trees (Picea glauca, Acer platanoides) were determined parallel to the light-induced in vivo chlorophyll fluorescence to correlate changes in radar reflectivity signatures with changes in tree vitality during increasing water stress. The fluorescent signatures were measured using three different methods: (1) the red laser-induced chlorophyll fluorescence kinetics, (2) chlorophyll-fluorescence emission spectra, and (3) the differentiation between photochemical and non-photochemical quenching, using a PAM-fluorometer. The RCS changes considerably with increasing time after abscission of healthy needles and twigs from the tree. Several chlorophyll fluorescence parameters, such as decreasing Rfd values and decreasing height of the saturating fluorescence spikes, indicate decreasing photosynthesis of the leaves, needles, and twigs. The comparative results of the development of radar and fluorescence signals in cut-off plant parts are a first promising step towards the aim of creating a link between RCS signatures and tree vitality. (See also W91-03944) (Tappert-PTT)
W91-03947

LANDSAT TM STUDY OF AFFORESTATION IN NORTHERN SCOTLAND AND ITS IMPACT ON BREEDING BIRD POPULATIONS.
National Remote Sensing Centre, Farnborough (England).
J. M. Smith.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1369-1370. 4 ref.

Descriptors: *Environmental impact, *Land use, *Peat bogs, *Remote sensing, *Satellite technology, *Scotland, *Water birds, *Waterfowl, *Wetlands, Acidity, Birds, Forest ecosystems, Habitats, Peat soils, Reforestation.

The largest single area of actively growing acid bog in the UK lies in the far north of Scotland, and is of international importance physiographically, and for the variety and type of flora and fauna it supports. Pool systems which characterize the flatter areas of peatland provide feeding grounds for large numbers of breeding wetland birds. Since 1980, approximately 20% of the total area of blanket bog has been afforested, reducing drastically the area of suitable habitat for many moorland birds. Young forest plantations are often difficult to identify on satellite imagery prior to canopy closure because of spectral similarity with surrounding cover type. Young plantations can be readily identified on Landsat TM imagery. During the first year after plowing, spectral response of exposed, deeply plowed and drained peat soils contrasts well with that of the surrounding vegetation. Contrast with surrounding moorland vegetation communities diminishes during the first 2-3 years after plowing as sites dry out and natural vegetation regenerates. Areas of ecologically important pool systems can also be detected and TM imagery offers the potential to map areas of suitable wader habitat. TM imagery can potentially meet many of the information requirements which conservation bodies have faced in assessing the impact of afforestation on the peatland environment and on breeding bird populations, and can also assist in identifying areas for future conservation. (See also W91-03944) (Tappert-PTT)
W91-03948

QUANTITATIVE REMOTE DETECTION OF SUSPENDED SEDIMENT CONTENT AND CHLOROPHYLL CONCENTRATION OF WATER IN DIFFERENT DEPTHS.
Institute of Karst Geology, Guilin (China).
S. Shu, and J. Chen.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1373-1377. 2 fig, 4 tab, 8 ref.

Descriptors: *Chlorophyll, *Instrumentation, *Radiometry, *Remote sensing, *Suspended sediments, *Water analysis, Measuring instruments, Regression analysis, Satellite technology.

A new method to measure suspended sediment concentration (SC) and chlorophyll concentration (CC) in different depths of water uses a specially designed device which includes a portable spectral radiometer and a water sampler. Water samples from different depths can be pumped into the device and their spectral characteristics measured by a spectroradiometer. Multivariate regression analysis shows a significant correlation between the reflectance and the concentrations of suspended sediment or chlorophyll. The sediment and chlorophyll concentrations could be estimated from spectral reflectance by using regression models with average relative errors of 3.6% and 3.4%, respectively. The new technique takes only four minutes to measure SC and CC from a water body. The method will be an effective tool for water quality monitoring, and when satellite imagery is used to estimate the CC and SC of water this spectral method can be used in ground truthing investigations to calculate satellite measurements. (See also W91-03944) (Author's abstract)
W91-03949

OPTICAL PROPERTIES OF SEAWATER BODIES: MEASUREMENTS WITH AN UNDERWATER RADIOMETER AND A HIGH-RESOLUTION SPECTRORADIOMETER.
Commission of the European Communities, Ispra (Italy). Joint Research Centre.
G. Maracci, and M. Ooms.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1379-1380. 3 fig, 2 tab, 4 ref.

Descriptors: *Chlorophyll, *Data acquisition, *Instrumentation, *Radiometry, *Water analysis, Bay of Naples, Measuring instruments, Seawater.

The optical properties of water bodies important for the calibration of algorithms computing quantitative chlorophyll content and based upon remotely sensed data. Chlorophyll content of two different water bodies was measured using two different instruments. The first instrument, an EOS underwater radiometer, is used for the determination of underwater downwelling and upwelling radiation. The immersible instrument allows the determination of the light attenuation coefficient k and the reflectance R as a function of depth for 4 different wavelengths, corresponding to the CZCS channels. The second instrument, an SE590 spectroradiometer, is a field portable data logging spectroradiometer for simultaneous acquisition of 256 bands in the range of 380-1100 nm by means of a diffraction grating and a photodiode array. The high resolution constitutes the latest state of the art in new radiometer technology. Both narrow band measurements of single channels and integration of measurements over selected ranges are possible. Both instruments were used in a sea truth campaign in the Bay of Naples and the results are compared with in situ chlorophyll data. Two different stations with different chlorophyll contents were investigated. Optical in situ data are in good agreement with analytical results of chlorophyll determination. (See also W91-03944) (Tappert-PTT)
W91-03950

IMPACT OF MULTIVIEWING REFLECTANCE DATA ON THE ESTIMATION OF SUSPENDED SEDIMENT CONCENTRATION.
Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
E. M. L. M. Novo.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1381-1384. 2 fig, 3 tab, 23 ref.

Descriptors: *Data acquisition, *Instrumentation, *Radiometry, *Reflectance techniques, *Remote sensing, *Suspended sediments, *Water analysis, Regression analysis, Sediments, Statistical studies.

Remotely sensed water radiance has proved to be a useful adjunct to conventional techniques for suspended sediment concentration (SSC) assessment as it provides an instantaneous synoptic view of water. Sensing geometry parameters (illumination and sensor look angles) affect the measurement of water radiance. An experiment was performed to test the suitability of using reflectance data measured with different viewing geometries to improve the estimation of SSC. Laboratory simulation of 35 suspended sediment concentrations and 14 different sensing geometries was carried out to derive the SSC reflectance relationship. Variation in SSC was simulated by adding successive known amounts of sediment to 300 liters of water. The tested concentrations ranged from 0 mg/l to 1050 mg/l. Water reflectance in four wavebands was derived from near sequential measurements of relative radiance from the target and a calibrated panel for each SSC and sensing geometry. Seven different viewing angles were used. The data was divided into two sets of reflectance data; one set was comprised of multispectral data, and one set was comprised of multiviewing variables. The results from stepwise regression supported the idea that multiviewing algorithms provides better estimates of suspended sediment concentration from water reflectance. The standard error of estimate decrease from 89.00 mg/l with the multispectral model to 24.39 mg/l with the multiviewing model. The explanatory power of viewing variables, however, varied with wavebands. Visible wavelengths were more affected by the inclusion of viewing variables than infrared wavelengths. (See also W91-03944) (Tappert-PTT)
W91-03951

DATA PROCESSING FOR THE DETERMINATION OF PIGMENTS AND SUSPENDED SOLIDS FROM THEMATIC MAPPER DATA.
Freiburg Univ. (Germany, F.R.). Inst. for Physical Geography.
B. Grunwald, W. Mauser, and K. Schneider.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1385-1389. 6 fig, 10 ref.

Descriptors: *Chlorophyll, *Data acquisition, *Instrumentation, *Lakes, *Landsat images, *Limnology, *Reflectance techniques, *Remote sensing, *Satellite technology, *Suspended solids, Germany, Lake Constance, Regression analysis, Water analysis.

Information about the spatial distribution of pigments and suspended solids in water bodies is of interest because of its close relationship to other ecological parameters such as temperature, currents, internal waves and primary production. The use of Thematic Mapper data has been used for determination of chlorophyll and suspended solids in Lake Constance, a large lake in the southwestern region of Germany. Although Thematic Mapper is a scanner built for land use rather than marine or freshwater research it is the only satellite-mounted scanner that holds a channel in the blue region of the spectrum in combination with high spatial resolution, a requirement for evaluation of the variable chlorophyll concentrations found in large experimental areas such as Lake Constance. Data preprocessing includes destriping, and an atmospheric correction model accounts for light scattering and absorption in the atmosphere. A non-linear multiple regression model for chlorophyll A was developed, using a database of 43 water samples collected on August 17, 1987. The regression model for chlorophyll is found to be significant up to the 90 percent level with a regression coefficient of 0.659. The chlorophyll concentrations were particularly low due to weather conditions, and the utility of Thematic Mapper data for determining even low concentrations was demonstrated. (See also W91-03944) (Tappert-PTT)
W91-03952

MONITORING OFFSHORE WATER QUALITY FROM SPACE.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
J. Topliss, L. Payzant, and P. C. F. Hurley.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1399-1402. 1 fig, 1 tab, 10 ref.

Descriptors: *Coastal waters, *Data acquisition, *Instrumentation, *Radiometry, *Reflectance techniques, *Remote sensing, *Satellite technology, Canada, Chlorophyll, MOS-1 sensor system, Optical properties, SPOT sensor system, Secchi disks, Turbidity, Water analysis.

The Secchi disc depth is often used as a measure of visible water turbidity to provide some indication of water quality. Numerous satellite systems measure visible reflected light but only a few have the high sensitivity required to record the changes in reflected light from the ocean surface. Images from the Coastal Zone Color Scanner (CZCS) onboard the Nimbus-7 satellite were compared to survey data taken by fisheries vessels on the Scotian Shelf off the east coast of Canada. A significant relationship was found between the corrected satellite radiance ratio and the Secchi disc depth for data collected during several different years, although no significant relationship was determined for chlorophyll A concentrations. Data collected from coastal Japan was used to develop algorithms relating Secchi disc depth to spectral reflectance for wavebands from several different satellites. It was

shown that in some cases increased water turbidity can shift the water leaving optical signal out of the spectral range of a given satellite system and into the spectral range of another system. The data show that although the CZCS wavebands are not optimum in spectral position such imagery could supplement selected parameters for off-shore surveys. Other satellite sensors, in particular the SPOT and MOS-1 systems, would probably have better spectral capabilities for monitoring in-shore water quality. (See also W91-03944) (Tappert-PTT)
W91-03953

MONITORING OF SUSPENDED SEDIMENTS IN JATILUHUR RESERVOIR USING SATELLITE IMAGES.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
J. R. Moll.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1403-1404. 2 fig, 3 ref. Dutch National Remote Sensing Program Grant No. 4532/TO-2.7.

Descriptors: *Data acquisition, *Erosion, *Instrumentation, *Reflectance, *Remote sensing, *Reservoirs, *SERES-1 model, *Satellite technology, *Suspended sediments, Computer programs, Jatiluhur Reservoir, Java, Landsat images, Model studies, SPOT sensor system.

The material that is dissolved or suspended in water bodies determines the amount of backscattered energy; this principle is used to monitor erosion using remote sensing data. The measurement of sedimentation in reservoirs is used to extrapolate erosional dynamics. Concentrations of suspended sediments in a reservoir are related to functions of SPOT and LANDSAT-measured digital photon counts. Jatiluhur Reservoir on West Java was selected as a case study. Ground truth data for suspended sediment in the reservoir were computed using the mathematical model SERES-1 (Sedimentation in Reservoirs), as ground measurements were not available at the time of the satellite overpasses. The model was calibrated using a topographic map predating construction of the reservoir and a bottom survey done in 1982. The results are promising, and temporal and spatial extrapolation possibilities of the obtained relationships will be investigated in a follow-up study. (See also W91-03944) (Author's abstract)
W91-03954

PRELIMINARY STUDY ON NEARSHORE WATER IN CHINA WITH NOAA SATELLITE IMAGES.
National Bureau of Oceanography, Hangzhou (China). Second Inst. of Oceanography.
X. Baide, and S. Xingwei.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1413-1416. 5 fig, 3 ref.

Descriptors: *Coastal waters, *Data acquisition, *Infrared radiation, *Instrumentation, *Remote sensing, *Sand waves, *Satellite technology, China, Reflectance, Water temperature.

The distributions of nearshore water surface temperature (ST) on the Northern Jiangsu and Southern Bohai Sea were obtained using data from the fourth channel of AVHRR on NOAA satellites. Data was collected during September to December 1987 on a wavelength range of 10.3 to 11.3 microns. Only the surface layer, approximately 20 microns deep and termed the skin layer, plays an important part in reflecting infrared radiation. It is clear that the ST distribution in a nearshore water mass near Northern Jiangsu appears in a radiant pattern, with the formation of underwater sand ridges apparent on the images. ST distribution on the southern Bohai Sea appears to be a clockwise whorl in the vicinity of Shidao. A preliminary study on the relationship between nearshore waters ST and the topography of the shallow marine bottom, such as radiant sand ridges, indicates that satellite data can be used to infer the genesis and hydrodynamics of the bottom topography. (See also W91-03944) (Tappert-PTT)
W91-03955

SATELLITE REMOTE SENSING FOR HYDROLOGICAL MONITORING AND WATER MANAGEMENT IN GREAT BRITAIN.
Bristol Univ. (England). Dept. of Geography.
E. C. Barrett, R. W. Herschy, J. O. Bailey, A. R. Harrison, and R. M. Lucas.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1539-1540.

Descriptors: *Data acquisition, *Instrumentation, *Maps, *Remote sensing, *Satellite technology, *Snow accumulation, *Snow cover, *Snow surveys, Ablation, England, Hydrologic maps, Radar, Rainfall, Scotland, Snowline, Snowmelt, Wales, Water resources management.

Precipitation, evapotranspiration, and snow cover are all important parameters for many aspects of hydrology and water management. Work is being performed for the UK Department of the Environment to design, develop and demonstrate satellite-based techniques for improved hydrological monitoring in England, Scotland and Wales. At present information on snow cover in the United Kingdom relies on reports from voluntary observers. A new set of methods utilizing satellite-based weekly maps of snow area have been developed for use in water management. Snow classification algorithms have been developed using NOAA AVHRR/HRPT satellite imagery, using either visible or multispectral data. The percentage errors of the classifications have been obtained by differentiating between land and sea areas, and applying the snow area algorithms to both. Routines have been developed to allow for the effects of forest cover on apparent snow area statistics, and for the creation of a digital terrain model to generate slope and aspect corrections to compensate for unwanted terrain shadow effects. Radar and satellite rainfall monitoring techniques have been applied to the United Kingdom as well, with radar results from the FRONTIERS project of the British Meteorological Office and satellite-derived rainfall estimates produced by the application of the Bristol/NOAA InterActive Scheme (BIAS). (See also W91-03944) (Author's abstract)
W91-03956

IMPROVEMENTS IN GROUNDWATER RECHARGE ESTIMATION USING SATELLITE REMOTE SENSING.
University Coll., Cardiff (Wales). Dept. of Civil and Structural Engineering.
R. S. Drayton, M. A. M. Said, and N. J. Carter.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1541-1542. 1 fig, 1 tab, 1 ref.

Descriptors: *England, *Glacial drift, *Groundwater movement, *Groundwater recharge, *Landsat images, *Remote sensing, Finite difference methods, Groundwater resources, Land cover, Model studies, Soil types.

In conventional groundwater models the accurate representation of groundwater flow has been held back by the difficulties encountered in estimating recharge. Because remote sensing is commonly used to identify land cover and soil types, it can provide useful information with regard to the land cover and the distribution of glacial drift in recharge areas. An existing finite-difference model of the River Worfe catchment, an important aquifer in Central England, has been used to check the sensitivity of groundwater predictions to changes in land cover and drift. A LANDSAT image of the catchment area was rectified and geo-referenced, and a land cover map was generated using the same land cover categories as the groundwater model. It was determined that if the proportions of land cover types are assumed to be constant all over the catchment, then gross changes in the relative proportions have little effect upon groundwater recharge. However, small changes in the distribution of drift have a major impact upon recharge estimation. The most successful technique for identifying drift areas was to perform a textural analysis, classifying the image on the basis that the agricultural patterns in drift areas were significantly different from those outside drift areas. A methodology for improving recharge estimation using remote sensing is given, and the improvements in the model results are quantified. (See also W91-03944) (Tappert-PTT)
W91-03957

ASSESSMENT OF ATM AND SATELLITE DATA FOR ESTIMATING THE GROUNDWATER CONTRIBUTION TO SLOPE STABILITY.
University Coll., Cardiff (Wales). Dept. of Civil and Structural Engineering.
R. S. Drayton, M. P. Hughes, and M. R. Taylor.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1543-1544. 1 tab, 3 ref.

Descriptors: *Data acquisition, *Groundwater, *Landsat images, *Landslides, *Remote sensing, *Slope stability, *Soil water, *Springs, Digital elevation models, Land cover.

Landslips are a serious environmental hazard in many parts of the world. Groundwater conditions are frequently used in the assessment of the stability of slopes. Although groundwater cannot be directly detected by remote sensing instruments, seepage such as springs or localized changes in soil moisture can be readily detected. Three sites in the Rhondda Fawr valley in England were selected for detailed study to detect seasonal variations in soil moisture which are indicative of groundwater conditions. Airborne Thematic Mapper (ATM) data was collected from an altitude of 4000m on two flights, corresponding to end-of-winter (May) and end-of-summer (September). Landsat Thematic Mapper (TM) imagery was also available, along with a digital elevation model (DEM) for the study area. The spectral resolution of the ATM data was sufficient to be able to easily identify historically active slips, largely on the basis of their characteristic geomorphology. However, the imagery was so grossly distorted that it was impossible to georeference the ATM without significant residual errors; this problem remains the main stumbling block to using ATM imagery for site-specific engineering applications. LANDSAT data was georeferenced and used to generate a land cover classification map, which was combined with the DEM to create a landslip potential map which compared favorably to the map produced with conventional techniques. (See also W91-03944) (Tappert-PTT)
W91-03958

SIMULATING TEST FOR SOIL MOISTURE SENSING.
China Research Inst. of Radiowave Propagation, Xinxiang.
J. Ji.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1555-1556. 2 fig, 1 tab, 2 ref.

Descriptors: *Data acquisition, *Radar, *Remote sensing, *Soil water, Backscatter, Testing procedures.

For active microwave remote sensing of soil moisture. it is important to study the correspondence between soil moisture and backscattering coefficients. The main factors controlling backscattering

from baresoil are soil moisture, soil surface roughness, and soil texture. A sample-on-plank simulating test for the remote sensing of baresoil moisture was conducted using X-band scatterometer results during the last two months of 1986. The soil sample, thicker than 20 cm, was set on a rectangular wood plank which can be moved to simulate different angles of incidence. Homogeneous soil surface roughness is maintained by special plates. The X-band scatterometer is FM-CW radar with a center wavelength of 3.2 cm. The sample test has the advantage in reducing the error which comes from the inhomogeneity of soil moisture and that of soil surface roughness in measuring the backscattering coefficients at different incidence angles in the field. In general, the angular responses of backscattering coefficients are strongly dependent upon surface roughness, although only two roughness configurations were tested. Additional tests in a wider variety of roughness coefficients are required to confirm the effects of surface roughness. (See also W91-03944) (Tappert-PTT)
W91-03961

MICROWAVE X-BAND RADIOMETRIC CHARACTERIZATION OF BRAZILIAN SOILS BY MEASUREMENT OF THE COMPLEX PERMITTIVITY.
Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
U. W. Palme.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1557-1561. 10 fig, 13 ref.

Descriptors: *Brazil, *Data acquisition, *Instrumentation, *Microwaves, *Radiometry, *Remote sensing, *Satellite technology, *Soil surveys, *Soil water, Agriculture, Field tests, Soil chemistry, Soil types.

Spaceborne remote sensing techniques in the visible and infrared ranges have been used in Brazil since the 1970s. However, the high percentage of cloud coverage and highly weathered soils typical of the region reduce the usefulness of the data. Microwaves, besides being less influenced by clouds, provide higher penetration rates in the soil and generally larger contrast ranges. This has led to the wide use of microwaves, particularly in the northern hemisphere, to estimate soil moisture and salinization processes on a regional basis. Estimating and monitoring soil moisture conditions over extensive areas using microwave techniques requires a knowledge of the complex permittivity of the soils as a function of soil moisture. Laboratory measurements of this parameter were made for six agriculturally important Brazilian soils, at five different levels of soil moisture. Two field tests on three of the soils were carried out. Some relevant results regarding measurements of the complex permittivity as estimates of emissivity for soils from tropical areas at 10.62 GHz indicate that the chemical characteristics of the soil may present a greater challenge to evaluating the relationship between complex permittivity and soil moisture. Data from soils high in iron oxides and organic matter do not agree well with predicted results and additional research is under way in this area. (See also W91-03944) (Tappert-PTT)
W91-03962

MICROCOMPUTER-BASED RADIOMETER DATA ACQUISITION AND PROCESSING SYSTEM FOR LARGE-AREA MAPPING OF SOIL MOISTURE CONTENT IN THE TOP ONE METER LAYER.
Akademiya Nauk SSSR, Moscow. Inst. Radiotekhniki i Elektroniki.
F. A. Mkrtchjan, E. A. Reutov, A. M. Shutko, K. G. Kostov, and M. A. Michalev.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1563-1564. 2 fig, 7 ref.

Descriptors: *Bulgaria, *Computer programs, *Data acquisition, *Microcomputers, *Microwaves, *Radiometry, *Remote sensing, *Soil water, Aircraft, Data processing, Mapping.

An airborne microcomputer-based radiometer data acquisition and processing system for mapping the soil moisture content in the top one meter layer has been used in Bulgaria to develop agricultural information. The system consists of two radiometers operating at wavelengths of 18 and 30 cm, a microcomputer system for radiometer data preprocessing and recording on board an aircraft, and software for estimating and mapping the water content in the top one meter layer. Both radiometer data and a priori information about the hydrophysical properties of the soils are used by the program to estimate soil moisture. Tests of the system were conducted in April-July 1987. Fifteen agricultural fields with an area of 700 km were overflown and soil moisture maps prepared. Several fields were overflown twice, separated by 3 to 7 days, to monitor changes in soil moisture. Groundtruthing was carried out coincident with the flights. The results of the test flights have shown the potential of the system for near real-time mapping of the water content in the top one meter layer with accuracy to 0.05g/cu cm, if the top biomass is less than 2 kg/sq m. The system has proved to be reliable aboard an aircraft and may be used as an operational system for near-real time soil moisture mapping. (See also W91-03944) (Tappert-PTT)
W91-03963

ESTIMATION OF THE AREA OF LAKE KARIBA, ZIMBABWE, USING LANDSAT MSS IMAGERY.
Aston Univ., Birmingham (England). Remote Sensing Unit.
D. J. Booth, and R. B. Oldfield.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1565-1567. 1 fig, 1 tab, 1 ref.

Descriptors: *Data acquisition, *Lakes, *Landsat images, *Remote sensing, *Satellite technology, *Water level fluctuations, *Zimbabwe, Water resources.

Lake Kariba, on the Zambezi River in Zimbabwe, is one of the world's largest manmade lakes and is used for both hydroelectric power and irrigation. Drops in water level due to droughts have created an interest in monitoring lake area using satellite imagery, relating the data to water levels, and using it for input to hydrological/evaporation models. Satellite imagery has several advantages over conventional mapping/survey and photogrammetric techniques in terms of cost, time, frequency of data collection, and technical considerations. Several LANDSAT scenes were selected to provide total lake coverage under the complete range of lake levels. Adjacent scenes were joined together to provide a complete picture of the lake. Pixels were identified as water or soil and counted to determine the area of the lake. The original estimates of the lake area, taken at the time of construction are in close agreement with those measured from satellite data. The project is a good demonstration of the practical value of satellite data, but also indicates difficulties in ground control pointing and geometric correction that are much more difficult in practice than in theory. (See also W91-03944) (Tappert-PTT)
W91-03964

OBSERVATIONS ON THE EFFECT OF GEOMETRIC PROPERTIES OF AGRICULTURAL SOILS ON RADAR BACKSCATTER, FROM C-SAR IMAGES.
Sherbrooke Univ. (Quebec). Centre d'Applications et de Recherches en Teledetection.
A. Beaudoin, T. L. Toan, and Q. H. J. Gwyn.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1595-1598. 6 fig, 3 ref.

Descriptors: *Agriculture, *Canada, *Data acquisition, *Radar, *Remote sensing, *Soil water, Cropland, Satellite technology.

Past studies using ground-based scatterometers have indicated that C-band radar, operating at 15-20 degrees of incidence angle, is an optimum configuration for soil moisture detection. The effects of the geometric properties of agricultural surfaces on the analysis of C-band SAR images must be understood. An experiment was conducted in an agricultural area in Quebec, Canada to determine the disturbing effects of agricultural surfaces on the SAR images. Five radar images were acquired over the test site in June 1987. Three flight lines providing different look angles were selected. The multi-image analysis is made possible by a relative calibration method using a natural extended target (dense forest stands). Quantitative results are obtained for the effect of (a) the soil moisture variation induced by a particular large-scale surface pattern, (b) the look angle relative to a row crop direction, and (c) the small-scale roughness. Groundtruthing data included soil moisture samples, plant canopy data, and surface roughness measurements. The results show that for soil moisture inversion using airborne SAR images, both look angle and small-scale roughness must be taken into account. The experimental results will be used to validate models aiming at simulating the effects of field geometric properties, at incidence angles of future spaceborne SARs. (See also W91-03944) (Tappert-PTT)
W91-03965

WATER RELATIONS OF A WALNUT ORCHARD: SIMULTANEOUS MEASUREMENT WITH REMOTE SENSING.
Michigan Univ., Ann Arbor. Biological Station.
J. A. Weber, and S. L. Ustin.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1749-1751. 11 ref.

Descriptors: *Data acquisition, *Instrumentation, *Microwaves, *Plant water potential, *Remote sensing, *Water potentials, Backscatter, Diurnal distribution, Leaves, Transpiration, Trees.

Study of water relations encompasses not only water status but also the dynamic processes of transpiration and water flux through the plant. Water relations of trees vary over time scales of hours to weeks. Several studies have indicated the utility of optical data to determine water relations. The effects of changes in water status on microwave backscatter measurements from tree canopies was determined in an experiment conducted on a grove of walnut trees on an experimental orchard in California. Several parameters were measured to provide a broad picture of water status for comparison with concurrently acquired microwave and optical data. Fresh and dry weight, water and osmotic potential of leaves were measured periodically during the experimental period. Of the several parameters measured, leaf xylem water potential showed the greatest diurnal variation and appeared to co-vary in time with C, L, and X-band microwave measurements. In addition, data collected with L-band dielectric probes embedded in the trunk of selected trees showed parallel temporal variations. It is unlikely that water potential, per se, is being sensed; however, water potential of the leaves is a sensitive measure of overall plant water status and is a useful parameter for connecting remotely sensed data to plant activity. (See also W91-03944) (Author's abstract)
W91-03966

SNOW COVER-SUMMER MONSOON RAINFALL OVER PARTS OF SAHEL.
Nairobi Univ. (Kenya).
O. S. R. U. Bhanu Kumar.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988

International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1847-1848. 1 fig, 6 ref.

Descriptors: *Monsoons, *Remote sensing, *Satellite technology, *Snow cover, *Snow surveys, *Snowmelt, *Statistical methods, Africa, Sahel, Seasonal variation.

Remotely sensed snow cover using satellite technology was compared to summer monsoon rainfall over 15 stations in the Sahel zone of west Africa, for the time period of 1967-1984. The quality of the data is not consistent, and is more accurate over the last few years of the study period. The winter snowcover varied from 24 million sq km to 30 million sq km. There is an inverse relation between Sahelian rainfall and two parameters from the Eurasian snow cover, one being the winter snow cover extent and the other the area of spring snowmelt. Negative correlations to the above relations for each station are in the range of 0.3 to 0.5. The increasing trend of snow cover is consistent with decreasing trend of Sahelian rainfall. A significant power peak around 5 years was identified in winter snow, spring snowmelt and monsoon rains. The higher significant negative correlation between the Eurasian winter snow cover and April ridge position reveals the profound effect of snow on atmosphere. (See also W91-03944) (Author's abstract)
W91-03967

SEASONAL OCCURRENCE OF AUTOTROPHIC NAKED NANOFLAGELLATES IN KIEL BIGHT, WESTERN BALTIC.
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.
For primary bibliographic entry see Field 2L.
W91-03984

AUTOCATALYTIC MODEL FOR THE KINETICS OF BOD TEST.
Nanjing Inst. of Technology (China). Dept. of Applied Chemistry.
For primary bibliographic entry see Field 5D.
W91-04038

SELECTIVE MEDIUM FOR ISOLATION OF MYCOLEPTODISCUS TERRESTRIS FROM SOIL SEDIMENTS OF AQUATIC ENVIRONMENTS.
EcoScience Labs., Inc., Amherst, MA.
R. Sneh, and J. Stack.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 11, p 3273-3277, November 1990. 1 fig, 4 tab, 4 ref.

Descriptors: *Aquatic fungi, *Aquatic weed control, *Biological control, *Laboratory methods, *Microbiological studies, *Selective media, *Water milfoil, *Weed control, Aquatic plants, Aquatic weeds, Biological treatment, Culture media, Fungi.

The fungus Mycoleptodiscus terrestris (Gerdemann) Ostazeski is being developed as a microbial control agent of the nuisance aquatic plant Eurasian watermilfoil, Myriophyllum specatum L. It is important to evaluate the fate and spread of M. terrestris after its introduction to an aquatic environment for the control of watermilfoil. A selective medium was developed for the dilution plate isolation of Mycoleptodiscus terrestris from natural soils and sediments from aquatic environments. The ingredients per liter of the selective medium were: 0.5 g KH2PO4; 0.5 g MgSO4 x 7H20; 10.0 g dextrose; 5.0 g peptone; 0.25 g chloramphenicol; 50 mg rose bengal; 5.0 g oxgall; 0.5 g Terraclor (pentachloronitrobenzene, 75% active ingredients); 15.0 g agar. After autoclaving, the following ingredients were aseptically added: 5.0 ml sorbic acid (0.7% autoclave-sterilized aqueous solution); 0.5 ml Subdue (25.1% emulsion of metalaxyl); and 0.05 ml Truban(40.7% suspension of etridiazol). The colony-restrictive properties of this medium enabled its use in the drop plate method, originally developed for viable counts of bacteria. Alfalfa sprouts as bait were not suitable for the quantitative recovery of the fungus, although 5% of alfalfa sprouts were infected with M. terrestris when incubated on soil containing 150 CFU/g. (Mertz-PTT)
W91-04063

USE OF NON-CONSERVATIVE PARAMETERS TO TRACE WASTEWATER EFFLUENTS IN WATER BODIES.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
For primary bibliographic entry see Field 5E.
W91-04079

JACKNIFE AND BOOTSTRAP ESTIMATION OF BIOLOGICAL INDEX OF WATER QUALITY.
Museo Nacional de Ciencias Naturales, Madrid (Spain).
For primary bibliographic entry see Field 5A.
W91-04084

BROMATE PRODUCTION IN CHLORINATED WATERS: REACTION OF MONOCHLORAMINE AND HYPOBROMITE.
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W91-04085

PREDICTION OF THE TEMPERATURE DEPENDENCE OF ELECTRICAL CONDUCTANCE FOR RIVER WATERS.
Freshwater Biological Association, Wareham (England). River Lab.
J. D. R. Talbot, W. A. House, and A. D. Pethybridge.
Water Research WATRAG, Vol. 24, No. 10, p 1295-1304, October 1990. 4 fig, 6 tab, 26 ref.

Descriptors: *Computer programs, *Conductivity, *Data acquisition, *Rivers, *Water analysis, *Water temperature, Computers, Mathematical equations.

Measurement of the electrical conductivity of rivers and lakes has become an important element in the assessment of water quality and is routinely included in many monitoring surveys. The most significant drawback with the measurement is that electrical conductance is strongly dependent on the water temperature. The application of mixed electrolyte theories to the prediction of the electrical conductivity of 14 river water samples covering a range of ionic strength and temperatures between 5 and 25 C has been evaluated using a new computer program, CONCAL. Both the Fuoss-Onsager, and Lee-Wheaton theories produce better agreement between the measured and predicted conductivities for the majority of the samples than the simple product equation. For river waters with a charge imbalance of less than 10%, the prediction of the simple product, Fuoss-Onsager and Lee-Wheton equations are on average within 11.1, 3.4, and 3.7%, respectively, of the experimental values over the range of temperatures considered. The major error in the predictions of the Fuoss-Onsager and Lee-Wheaton models is associated with the reliability of the chemical analytical data input to CONCAL. The accuracy of the predictions of the models is also discussed in terms of the magnitude and sign of the charge imbalance calculated for each of the samples from the analytical data. Five equations that are available to apply to temperature compensation to conductivity data to predict values at 25 C have been tested over a temperature range of 5-15 C. The best performance is achieved using the modified Walden's product. (Mertz-PTT)
W91-04086

SHORTCOMINGS OF GRAN TITRATION PROCEDURES FOR DETERMINATION OF ALKALINITY AND WEAK ACIDS IN HUMIC WATER.
National Inst. of Public Health, Oslo (Norway).
D. Hongve.
Water Research WATRAG, Vol. 24, No. 10, p 1305-1308, October 1990. 3 fig, 2 tab, 20 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidic water, *Humic substances, *Hydrogen ion concentration, *Water chemistry, Carbonates, Gran titration, Humic acids, Laboratory methods, Model studies, Organic acids, Simulation analysis, Titration.

In the research about causes and consequences of lake acidification, various procedures are used for measurement of acid/base properties of dilute natural waters. The carbonates that usually are the most important buffering compounds in freshwater may be almost depleted by external supply of strong acids. Other weak protolytes will then take over the buffer function at lower pH. Gran titrations of humic water for the determination of alkalinity and weak acids have been simulated by means of empiric models for acid/base properties of humic substances. One such model permits the easy calculation of concentrations of protolyzed species at various total concentrations of organic acids and pH. The model is based on the acid/base properties of isolated humic substances, assuming that the majority of organic solutes in colored water have similar properties. The results demonstrate that organic anions contribute significantly to the measured acid neutralizing capacity, and that weak acids concentration will be underestimated. The magnitude of analytical error depends on the pH of the data sampling range. (Mertz-PTT)
W91-04087

DESIGN AND APPLICATION OF A CONSTANT HEAD WELL PERMEAMETER FOR SHALLOW HIGH SATURATED HYDRAULIC CONDUCTIVITY SOILS.
Water Authority of Western Australia, Perth.
R. W. Bell, and N. J. Schofield.
Hydrological Processes HYPRE3, Vol. 4, No. 4, p 327-342, October/December 1990. 7 fig, 3 tab, 27 ref.

Descriptors: *Groundwater movement, *Hydraulic conductivity, *Instrumentation, *Measuring instruments, *Permeameters, *Saturated flow, *Soil analysis, Boreholes, Design criteria, Mathematical models, Model studies.

A new constant head well permeameter was designed to measure saturated hydraulic conductivities (Ks) ranging from .000001 to .001 m/sec. Application to shallow soils of Western Australia in this Ks range highlighted problems with different aspects of the borehole discharge response. Firstly steady-state borehole discharge was only reached in 13 out of 50 tests conducted. This was a consequence of the constraint placed on the volume of water storage (40 L) of the permeameter. For some non-steady-state cases, early time tests were used to estimate steady-state discharge from the available data. Borehole discharge was observed to increase with time in 34% of cases. A satisfactory physical explanation of this phenomenon is not available. The permeameter method does not provide an accurate measure of the sorptive number. Because the permeameter is constrained in volume, and somewhat in time, steady-state borehole discharge will not be reached with a high frequency. Examination of a number of recent theoretical developments in the determination of Ks led to a preference of saturated-unsaturated flow solutions by other researchers. These solutions involve the sorptive number to which the solutions were sensitive but not critically sensitive. The theory was used to establish design criteria for the permeameter and to identify an optimum application strategy in terms of well dimensions and heads. Error estimation indicated that the designed permeameter was a practically useful field instrument. (Geiger-PTT)
W91-04102

AT-A-POINT BED LOAD SAMPLING IN THE PRESENCE OF DUNES.
Indiana State Univ., Terre Haute. Dept. of Geography and Geology.
For primary bibliographic entry see Field 2J.
W91-04125

COMPARISON OF PHOTON CORRELATION SPECTROSCOPY WITH PHOTOSEDIMENTATION ANALYSIS FOR THE DETERMINATION OF AQUEOUS COLLOID SIZE DISTRIBUTIONS.
Geological Survey, San Diego, CA.
For primary bibliographic entry see Field 5B.
W91-04131

USE OF NUCLEAR MAGNETIC RESONANCE AS AN EXPERIMENTAL PROBE IN MULTIPHASE SYSTEMS: DETERMINATION OF THE INSTRUMENT WEIGHT FUNCTION FOR MEASUREMENTS OF LIQUID-PHASE VOLUME FRACTIONS.
California Univ., Davis.
J. E. Maneval, M. J. McCarthy, and S. Whitaker.
Water Resources Research WRERAQ, Vol. 26, No. 11, p 2807-2816, November 1990. 8 fig, 40 ref.
NSF Grant CBT-88-12870.

Descriptors: *Analytical techniques, *Groundwater movement, *Model studies, *Multiphase flow, *Path of pollutants, Multiphase transport, Nuclear magnetic resonance.

The presence of multiple physical phases in many practical problems (for example, oil recovery operations, groundwater transport, chemical reactor design) gives rise to a number of challenging theoretical and experimental problems. The relativist approach to the interpretation of measurements in multiphase systems was proposed in order to incorporate the details of measurements into theoretical analyses of multiphase transport processes. To help establish the utility of this approach, the weight functions for actual experimental probes must be determined. The measurement of liquid-phase porosity in a model system was analyzed by nuclear magnetic resonance imaging. It was shown that both nuclear magnetic resonance physics and experimental techniques combined to determine the weight function for the spin-warp spin-echo sequence. The analysis showed clearly what aspects of the weight function were determined by the experimental method and what aspects were determined by the system being studied. For the spin-warp imaging sequence the length scales of the instrument in the slice and phase-encode directions were determined predominantly by experimental technique and instrumental limitations. In contrast, both the experimentalist and the system interact to determine the scale of the measurement in the frequency-encode direction. The results will help establish the utility of the relativist approach as well as improve understanding nuclear magnetic resonance measurements in multiphase systems. (Mertz-PTT)
W91-04134

ANAEROBIC MICROBIAL DEGRADATION OF ACRIDINE AND THE APPLICATION OF REMOTE FIBER SPECTROSCOPY TO MONITOR THE TRANSFORMATION PROCESS.
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W91-04142

SIMPLIFICATION OF IN VITRO CULTURE TECHNIQUES FOR FRESHWATER MUSSELS.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
A. E. Keller, and S. G. Zam.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 10, p 1291-1296, 1990. 3 tab, 22 ref.

Descriptors: *Culture media, *Culturing techniques, *Endangered species, *Freshwater mussels, *Laboratory methods, Animal parasites, Aquatic animals, Aquatic populations, Shellfish, Toxicity testing.

Populations of freshwater mussels have been declining for several decades due to habitat destruction, pollution and sedimentation. Efforts to propagate rare and endangered species in the laboratory have been hampered by their need for fish as hosts during a brief parasitic phase in early development and, more recently, by cumbersome alternative methods. A simplified method for culture of several species of mussels was developed and tested. The use of sterile horse serum in the culture medium was found to reduce or eliminate bacterial growth common in cultures with fish plasma. A commercially available powdered tissue culture medium was substituted for the idiosyncratic medium previously used for mussel culture. Results indicated that incubation of mussel cultures in 5% carbon dioxide significantly improved transformation success. Anodonta imbecilis, Lampsilis teres and Villosa lienosa were successfully propagated using these methods. It is concluded that the procedures allow production of large numbers of juvenile mussels for replenishment of wild mussel populations or for toxicity testing. (MacKeen-PTT)
W91-04148

REMOTE IN SITU APPARATUS FOR AMBIENT TOXICITY TESTING OF LARVAL AND YEARLING FISH IN RIVER OR ESTUARINE SYSTEMS.
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
For primary bibliographic entry see Field 5C.
W91-04152

WATER-USE DATA FOR WATER RESOURCES MANAGEMENT.
For primary bibliographic entry see Field 6D.
W91-04161

WATER-USE REGISTRATION AND REPORTING IN INDIANA.
Indiana State Dept. of Natural Resources, Indianapolis. Div. of Water.
For primary bibliographic entry see Field 6D.
W91-04167

WATER USE AND METHODS OF DATA ACQUISITION IN MICHIGAN.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04176

FLOAT-POT ASSEMBLY TO MEASURE WATER LEVELS IN AN IRRIGATION CANAL.
Agriculture Canada, Lethbridge (Alberta). Research Station.
N. Foroud, and D. Hlibka.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 649-653, 5 fig.

Descriptors: *Instrumentation, *Irrigation canals, *Measuring instruments, *Water level, *Water table, *Water use data, Data acquisition, Field tests, Logging (Recording).

An instrumentation system that simultaneously records water table altitudes in digital and graphical forms was developed and installed to collect water level data in an irrigation canal. The major components of this device are a Stevens Fl recorder, an electronic datalogger, and a float pot unit. A Float Pot Interface electronically transfers absolute water level positions to an electronic datalogger in any present incremental time interval, while mechanically operating the clock driven pen carriage of a chart drum recorder. The proposed system provides an excellent means to make digital and graphical records of water level concurrently. (See also W91-04161) (Author's abstract)
W91-04230

MAPPING EVAPOTRANSPIRATION USING THE ENERGY-BUDGET METHOD WITH REMOTELY SENSED DATA.
Geological Survey, Phoenix, AZ. Water Resources Div.
L. H. Raymond, M. S. Moran, and R. D. Jackson.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 655-665, 8 fig, 5 ref.

Descriptors: *Data acquisition, *Data interpretation, *Evapotranspiration, *Mapping, *Remote sensing, *Water use data, Aerial photography, Agriculture, Alfalfa, Arizona, Comparison studies, Cotton, Energy, Graphical analysis, Landsat images, Vegetation, Water loss.

Hourly rates of evapotranspiration, calculated using the energy budget method with remotely sensed data from the Landsat 5 Thematic Mapper and from aircraft, were mapped over the Maricopa Agricultural Center, Arizona. Evapotranspiration rates calculated using Thematic Mapper data and rates calculated using aircraft data collected July 23 and on August 8, 1985, were compared over several fields of cotton, alfalfa, and bare soil. Differences between evapotranspiration rates calculated using the two data sources were attributed to differences in pixel size, number, and location. Increases in vegetation density corresponded to higher evapotranspiration rates calculated from the aircraft data than from the Thematic Mapper data. A comparison of changes in response by the aircraft data from July 23 to August 8, and by the Thematic Mapper data for those dates showed that both data sources could detect differences in evapotranspiration rates over time owing to changes in soil moisture and canopy closure. (See also W91-04161) (Author's abstract)
W91-04231

ESTIMATION OF GROUND-WATER USE FOR IRRIGATION IN EASTERN WASHINGTON USING LANDSAT IMAGERY.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 3F.
W91-04232

QUANTIFICATION OF TOXAPHENE RESIDUES IN FISH AND FISH PRODUCTS USING A NEW ANALYTICAL STANDARD.
Gesamthochschule Kassel (Germany, F.R.). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 5A.
W91-04248

COMPARATIVE EVALUATION OF SOXHLET AND SONICATION EXTRACTION IN THE DETERMINATION OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SOIL.
Environmental Monitoring Systems Lab., Las Vegas, NV. Methods Development Branch.
For primary bibliographic entry see Field 5A.
W91-04251

ORGANIC HALOGEN GROUP PARAMETERS IN GROUND WATER INVESTIGATION, PART III.
Technical Univ. of Denmark, Lyngby. Inst. for Applied Geology.
For primary bibliographic entry see Field 5A.
W91-04252

CAPILLARY ZONE ELECTROPHORETIC SEPARATION OF CHLOROPHENOLS IN INDUSTRIAL WASTE WATER WITH ON-COLUMN ELECTROCHEMICAL DETECTION.
Anamed Instruments Ltd., Bombay (India). Applictions and Methods Development Lab.
For primary bibliographic entry see Field 5A.
W91-04266

GAS CHROMATOGRAPHIC AND MASS SPECTROMETRIC DETERMINATION OF NITROAROMATICS IN WATER.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W91-04267

SIMULTANEOUS DETERMINATION OF TRACE CONCENTRATIONS OF BENOMYL, CARBENDAZIM (MBC) AND NINE OTHER PESTICIDES IN WATER USING AN AUTOMATED ON-LINE PRE-CONCENTRATION HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC METHOD.
Brock Univ., St. Catharines (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W91-04268

PH OF CLAY SUSPENSIONS IN THE FIELD AND LABORATORY, AND METHODS OF MEASUREMENT OF THEIR PH.
Missouri Univ., Columbia. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W91-04269

IMMOBILIZED PLANT THYLAKOID MEMBRANES AS A BIOSENSOR FOR HERBICIDES.
Quebec Univ., Trois-Rivieres. Centre de Recherche en Photobiophysique.
For primary bibliographic entry see Field 5A.
W91-04275

ASSESSMENT OF REFERENCE MATERIALS FOR APPLICATION TO PCDD/PCDF ANALYSIS.
Zenon Environmental, Inc., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W91-04278

WATER ROUND ROBIN FOR PARTS-PER-QUADRILLION DETERMINATION OF PCDDS AND PCDFS.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
For primary bibliographic entry see Field 5D.
W91-04279

VALIDATION STUDIES OF AN AUTOMATED PRECONCENTRATION WATER SAMPLER (APS) FOR CHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Ontario Ministry of the Environment, Rexdale.
M. Uza, R. Hunsinger, T. Thompson, and R. E. Clement.
Chemosphere CMSHAF, Vol. 20, No. 10-12, p 1349-1354, 1990. 1 fig, 2 tab, 3 ref.

Descriptors: *Dioxins, *Filtration, *Furans, *Halogenated compounds, *Ion exchange, *Pollutant identification, *Preconcentration, *Samplers, *Water analysis, Analytical methods, Automated preconcentration sampler, Chemical analysis, Flow rates, Instrumentation, Ontario, Performance evaluation, Resins, Water sampling.

The Automated Preconcentration Sampler (APS) was developed by the Ontario Ministry of the Environment (MOE) and Carleton University for the determination of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). The APS employs a two-stage particulate filtration system followed by an XAD-2 resin column. The capacity of the APS filtration system is 30 to 50 L. Flushing of a clean XAD-2 resin column with 200 L of spiked water showed that the optimum flow rate in terms of spike breakthrough is equal to three times the resin bed volume per minute. This flow rate is used for APS operation. Testing also showed that no spike breakthrough occurred after 200 L of clean water was flushed through a spiked XAD-2 resin column at flow rates in excess of the APS operating flow rate. The results of spike testing on the filters are pending. However, both field and laboratory testing of the APS will be required to validate the device before it is put into regular service. In addition, an analytical comparison between the present MOE sampling and analytical procedures and the proposed APS sampling and analytical procedure using a PCDD/PCDF source water is planned. (Author's abstract)
W91-04280

SUPERCRITICAL FLUID EXTRACTION FOR THE DETERMINATION OF PCDDS AND PCDFS IN SOIL.
Twin City Testing Corp., St. Paul, MN.
For primary bibliographic entry see Field 5A.
W91-04281

DEVELOPMENT OF GC CAPILLARY COLUMN FOR ISOMER-SPECIFIC SEPARATION OF TOXIC ISOMER OF PCDDS AND PCDFS IN ENVIRONMENTAL SAMPLES.
Waterloo Univ. (Ontario). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W91-04282

APPLICATION OF TANDEM QUADRUPOLE MASS SPECTROMETRY FOR THE ULTRA-TRACE DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
For primary bibliographic entry see Field 5A.
W91-04283

APPLICATION OF A TWO-DIMENSIONAL REACTION CHROMATOGRAPHY SYSTEM FOR CONFIRMATORY ANALYSIS OF CHLORDANE CONSTITUENTS IN ENVIRONMENTAL SAMPLES.
Missouri Univ.-Columbia. Environmental Trace Substances Research Center.
For primary bibliographic entry see Field 5A.
W91-04284

USE OF DIMETHYL SULFOXIDE AS SOLUBILIZATION AGENT IN THE DETECTION OF 2,3,7,8-TCDD BY RADIOIMMUNOASSAY.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
For primary bibliographic entry see Field 5A.
W91-04285

DEVELOPMENT OF A RAPID SCREENING ASSAY FOR PCDDS AND PCDFS.
Guelph Univ. (Ontario). Dept. of Chemistry and Biochemistry.
For primary bibliographic entry see Field 5A.
W91-04286

BROMO- AND BROMOCHLORO-P-DIOXINS AND DIBENZOFURANS IN THE ENVIRONMENT.
Lockheed Engineering and Sciences Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 5A.
W91-04287

MONITORING DIOXINS AND DIBENZOFURANS IN PRECIPITATION IN ONTARIO.
Ontario Ministry of the Environment, Toronto. Air Resources Branch.
For primary bibliographic entry see Field 5B.
W91-04288

CHARACTERIZATION OF SOLIDS TRANSFERRED INTO SEWER TRUNKS DURING WET WEATHER.
Centre d'Enseignement et de Recherche pour la Gestion des Ressources Naturelles et l'Environnement, Paris (France).
For primary bibliographic entry see Field 5D.
W91-04350

CONTINUOUS MONITORING OF WASTEWATER COMPOSITION IN SEWERS AND STORMWATER OVERFLOWS.
Universite Libre de Bruxelles (Belgium). Lab. de Traitement des Eaux et Pollution.
For primary bibliographic entry see Field 5D.
W91-04355

GROUNDWATER-LAKE INTERACTIONS: I. ACCURACY OF SEEPAGE METER ESTIMATES OF LAKE SEEPAGE.
Alberta Univ., Edmonton. Dept. of Zoology.
R. D. Shaw, and E. E. Prepas.
Journal of Hydrology JHYDA7, Vol. 119, No. 1/4, p 105-120, November 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *Alberta, *Groundwater movement, *Instrumentation, *Lakes, *Measuring instruments, *Minnesota, *Seepage, *Surface-groundwater relations, Flow velocity, Lake Sallie, Mathematical models, Monte Carlo method, Narrow Lake, Simulation.

The number of studies of groundwater-lake interactions has increased dramatically over the past decade. Seepage meters, simple devices to measure groundwater-lake interactions, have been introduced in parallel with this increased attention. The use of seepage meters to identify nearshore patterns and to quantify seepage in lakes was evaluated with a Monte Carlo simulation model. The model simulated seepage flux as would be derived from seepage water measurements along a transect extending from the shore of a hypothetical lake to 40 or 100 m offshore. Along the transect, simulated seepage velocities decreased exponentially with distance from shore according to patterns measured at Narrow Lake, Alberta, and Lake Sallie, Minnesota. To determine statistical parameters needed in the model, seepage flux was measured in situ with closely spaced seepage meters at four different sites in Narrow Lake. Seepage velocities within a small area of lakebed were log-normally distributed, and the variance was correlated positively with mean seepage flux. The modeling indicated that the most sensitive parameter affecting the accuracy of seepage meter estimates of seepage patterns and average seepage flux along the transect was the variability in the spatial distribution of seepage flux within a small area of lakebed. There was little improvement in the accuracy of estimates of seepage patterns or transect flux when more than 10 seepage meters were simulated along the transect, when the transect was 'sampled' more than twice, or when seepage meters along the transect were simulated to follow a stratified rather than a systematic design. (See also W91-04394) (Author's abstract)
W91-04393

RETRIEVAL OF PRECIPITABLE WATER FROM OBSERVATIONS IN THE SPLIT WINDOW OVER VARYING SURFACE TEMPERATURES.
Geophysics Lab. (AFSC), Hanscom AFB, MA.
For primary bibliographic entry see Field 2B.
W91-04433

PRECIPITABLE WATER ESTIMATION FROM HIGH-RESOLUTION SPLIT WINDOW RADIANCE MEASUREMENTS.
National Aeronautics and Space Administration, Huntsville, AL. George C. Marshall Space Flight Center.
For primary bibliographic entry see Field 2B.
W91-04434

PRINCIPAL FACTS FOR GRAVITY STATIONS IN THE ELKO, STEPTOE VALLEY, COYOTE SPRING VALLEY, AND SHEEP RANGE AREAS, EASTERN AND SOUTHERN NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
D. L. Berger, D. H. Schaefer, and E. A. Frick.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-30, 1990. 13p, 4 tab, 1 pl, 9 ref.

Descriptors: *Geophysical exploration, *Geophysical studies, *Gravity studies, *Nevada, Coyote Spring Valley, Elko, Sheep Range, Steptoe Valley.

Principal facts for 537 gravity stations in the carbonate-rock province of eastern and southern

Nevada are tabulated and presented. The gravity data were collected in support of groundwater studies in several valleys. The study areas include the Elko area, northern Steptoe Valley, Coyote Spring Valley, and the western Sheep Range area. The data for each site include values for latitude, longitude, altitude, observed gravity, free-air anomaly, terrain correction, and Bouguer anomaly (calculated at a bedrock density of 2.67 g/cu cm. (USGS)
W91-04473

ESTIMATING EVAPORATION FROM PASTURE USING INFRARED THERMOMETRY: EVALUATION OF A ONE-LAYER RESISTANCE MODEL.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2D.
W91-04487

IMPROVED PROSPECTS FOR ESTIMATING INSOLATION FOR CALCULATING REGIONAL EVAPOTRANSPIRATION FROM REMOTELY SENSED DATA.
Maryland Univ., College Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2D.
W91-04490

REMOTE ESTIMATION OF SOIL MOISTURE AVAILABILITY AND FRACTIONAL VEGETATION COVER FOR AGRICULTURAL FIELDS.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2G.
W91-04491

PRECIPITABLE WATER IN THE SAHEL MEASURED USING SUN PHOTOMETRY.
National Aeronautics and Space Administration, Greenbelt, MD. Hydrological Sciences Branch.
For primary bibliographic entry see Field 2B.
W91-04492

LOCALIZED FIELD IRRIGATION EFFICIENCIES FROM SOIL SALINITY SAMPLES.
Arizona Univ., Tucson.
For primary bibliographic entry see Field 3F.
W91-04541

DESIGN AND PERFORMANCE OF AN ACIDIC PRECIPITATION DELIVERY SYSTEM FOR FIELD INVESTIGATION WITH PLANTS.
Boyce Thompson Inst. for Plant Research, Ithaca, NY.
For primary bibliographic entry see Field 5C.
W91-04568

NEW METHOD TO MEASURE BULK ELECTRICAL CONDUCTIVITY IN SOILS WITH TIME DOMAIN REFLECTOMETRY.
Agricultural Univ., Wageningen (Netherlands). Dept. of Agricultural Engineering.
W. K. P. van Loon, E. Perfect, P. H. Groenevelt, and B. D. Kay.
Canadian Journal of Soil Science CJSSAR, Vol. 70, No. 3, p 403-410, August 1990. 3 fig, 1 tab, 17 ref.

Descriptors: *Conductivity, *Instrumentation, *Laboratory methods, *Measuring instruments, *Soil properties, Loam, Regression analysis, Sand, Soil saturation, Soil water, Time domain reflectometry.

The bulk electrical conductivity of a porous medium can be determined by measuring the reflection of an electromagnetic pulse in transmission lines which are installed in this medium, a method known as Time Domain Reflectometry (TDR). The reflection is not only influenced by the medium, but also by the measuring system. A new method was developed that corrects for influences on the measuring system by comparing a reflection measurement with a reference measurement performed in the air. Calibration measurements were make in water and in water-saturated sand and loam soils at different calcium chloride concentrations. Columns with different, well-determined solute concentrations were prepared. Linear regression analyses were performed between the electrical conductivity determined with TDR and the electrical conductivity of the solutions. All slopes were close to one and the correlation coefficients were high: 0.993, 0.993, and 0.968 for water, sand, and loam, respectively. For the two soils significant intercepts were found. These might be related to the surface charge of the soil particles. (Author's abstract)
W91-04585

SEDIMENT-CONTACT BIOASSAY WITH PHOTOBACTERIUM PHOSPHOREUM.
Redeemer Coll., Ancaster (Ontario).
For primary bibliographic entry see Field 5A.
W91-04626

ESTIMATION OF THE RELATIVE PERMEABILITY DISTRIBUTION IN FRACTURED GRANITIC ROCKS BY MEANS OF VERTICAL FLOW MEASUREMENTS IN THE SIBLINGEN BOREHOLE, SWITZERLAND.
Geological Survey, Denver, CO.
F. L. Paillet, A. E. Hess, and R. H. Morin.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations 90-4034, 1990. 26p, 10 fig, 6 tab, 13 ref.

Descriptors: *Aquifer testing, *Borehole geophysics, *Data acquisition, *Geohydrology, *Geologic fractures, *Groundwater movement, *Injection tests, *Instrumentation, *Permeability, *Pumping tests, Flowmeters, Granites, Injection, Measuring instruments, Switzerland, Vertical flow.

The U.S. Geological Survey has developed a geophysical measurement technique for determining the vertical distribution of permeability in fractured crystalline rocks by using measurements of vertical flow during pumping or injection tests in boreholes. The technique is based on measurements made with a recently developed thermal-pulse flowmeter and requires measurements at successively larger pumping or injection rates to determine permeability values. This technique was tested in a 1,522-meter-deep borehole in granitic basement rocks located near Siblingen, Switzerland. Before injection tests were begun, flowmeter logging indicated that a naturally occurring flow of about 1.1 L/min entered the borehole from a fracture zone at a depth of about 700 meters, and exited the borehole through fractured zones at depths of about 930 and 1,280 meters. Measurements of the vertical flow distribution were made during the steady injection of water at rates of 8 to 57 L/min. The unreliability of pressure logs intended to measure hydraulic head differences within the borehole precluded normalization of flows using direct measurements of the hydraulic head differences causing the flows. Flow measurements were normalized by using injection rates under the assumption that friction losses in the borehole were small. The vertical flow profile determined from U.S. Geological Survey flowmeter measurements will be available for comparison with permeability profiles generated for the Siblingen boreholes using other, conventional measurement methods. (Author's abstract)
W91-04643

COMPARISON OF ACCURACY AND COMPLETENESS OF DATA OBTAINED FROM THREE TYPES OF AUTOMATIC WATER-QUALITY MONITORS.
Geological Survey, Columbus, OH. Water Resources Div.
M. S. Katzenbach.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Water-Resources Investigations Report 89-4198, 1990. 65p, 29 fig, 6 tab, 2 ref.

Descriptors: *Automation, *Data acquisition, *Instrumentation, *Measuring instruments, *Monitoring, *Water analysis, *Water quality, Comparison studies.

A comparison of data (specific conductance, dissolved oxygen concentration, temperature, and pH) collected by the U.S. Geological Survey flowthrough monitor, the U.S. Geological Survey minimonitor, and a self-contained commercial 'packaged-sensor' system indicates that the data obtained by means of the flowthrough-monitor system were the most accurate and the most complete of the three systems. The U.S. Geological Survey flowthrough monitor is powered by 120-volt alternating current and is housed in a heated weather-proof shelter. A pumping system brings water from the stream to sensors clustered in a sample chamber located in the shelter. This instrument measures output from the sensors; data are recorded in binary-coded decimal form on a 16-channel punched-paper tape recorder housed in the shelter. The U.S. Geological Survey's minimonitor is powered by an external battery and is housed in a weatherproof shelter. This instrument measures the output of instream sensors with extension cables having underwater connectors; data are recorded in binary-coded decimal form on a 16-channel punched-paper tape recorder housed in the shelter. The package-sensor system also measures output of sensors housed in a package that is submerged in the stream. It has an internal power supply, no moving parts, and does not require a weatherproof shelter; data are stored in solid-state memory. Minimonitors were installed at four sites in Ohio where U.S. Geological Survey flowthrough monitors were in operation. Two packaged-sensor systems also were assigned to each site and were alternated every two weeks. Detailed records were kept of: (1) field measurements, for comparison with monitor-system data from each instrument; and (2) equipment problems that resulted in loss of data. Results of the comparisons show that the flow-through monitor gave the most accurate and the most complete data. (Author's abstract)
W91-04644

SMALL FLUME FOR STUDYING THE INFLUENCE OF HYDRODYNAMIC FACTORS ON BENTHIC INVERTEBRATE BEHAVIOR.
Alberta Univ., Edmonton. Dept. of Entomology.
For primary bibliographic entry see Field 2E.
W91-04716

IN SITU TECHNIQUE TO MEASURE BACTERIAL CHEMOTAXIS IN NATURAL AQUATIC ENVIRONMENTS.
Montana State Univ., Bozeman. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-04722

CORRELATION OF NONSPECIFIC MACROMOLECULAR LABELING WITH ENVIRONMENTAL PARAMETERS DURING (H3)THYMIDINE INCORPORATION IN THE WATERS OF SOUTHWEST FLORIDA.
University of South Florida, St. Petersburg. Dept. of Marine Science.
For primary bibliographic entry see Field 2H.
W91-04724

CARBON ISOTOPE DISCRIMINATION: POTENTIAL IN SCREENING COOL-SEASON GRASSES FOR WATER-LIMITED ENVIRONMENTS.
Agricultural Research Service, Logan, UT.
For primary bibliographic entry see Field 3F.
W91-04781

INDIANA WATER QUALITY, 1988. MONITOR STATION RECORDS, RIVERS AND STREAMS.
Indiana Dept. of Environmental Management, Indianapolis. Office of Water Management.
For primary bibliographic entry see Field 5B.
W91-04857

CONTINUOUS SEISMIC REFLECTION PROFILING OF HYDROGEOLOGIC FEATURES BENEATH NEW RIVER, CAMP LEJEUNE, NORTH CAROLINA.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04902

PSYCHROMETRIC MEASUREMENT OF SOIL WATER POTENTIAL STABILITY OF CALIBRATION AND TEST OF PRESSURE-PLATE SAMPLES.
New Mexico State Univ., Las Cruces.
T. L. Jones, G. W. Gee, and P. R. Heller.
Soil Science SOSCAK, Vol. 150, No. 2, p 535-541, 1990. 5 fig, 11 ref.

Descriptors: *Calibrations, *Humidity, *Instrumentation, *Measuring instruments, *Sampling, *Soil tests, *Soil water potential, Grain size, Performance evaluation, Psychrometry, Sand, Silt, Soil types, Soil water.

A commercially available thermocouple psychrometer sample changer (Decagon SC-10A) was used to measure the water potential of field soils ranging in texture from sand to silty clay loam over a range of -0.5 to -20.0 MPa. Replacing the measuring junction of the unit changed the calibration slightly; however, measurement accuracy was not significantly altered. Calibration curves measured throughout a year of testing are consistent and indicate no systematic drift in calibration. Most measurement uncertainty is produced by shifts in the intercept in the calibration equation rather than the slope. Both the variability in intercept and the regression error seem to be random. Measurements taken with the SC-10A show that water potential in both sand and silt loam samples removed from 1.5 MPa pressure plates was often 0.5 to 1.0 MPa greater than the 1.5 MPa applied pressure. Limited data from 0.5 MPa pressure plates show close agreement between SC-10A measurements and pressure applied to these more permeable plates. (Author's abstract)
W91-04912

SYSTEMATIZED DRILLSTEM TEST.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W91-04920

ANALYSIS OF OUTFLOW EXPERIMENTS SUBJECT TO SIGNIFICANT PLATE IMPEDANCE.
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
For primary bibliographic entry see Field 2G.
W91-04921

REGIONAL SURFACE FLUXES FROM REMOTELY SENSED SKIN TEMPERATURE AND LOWER BOUNDARY LAYER MEASUREMENTS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W91-04923

7C. Evaluation, Processing and Publication

AQUIFER PROTECTION THROUGH LARGE SCALE COMPUTER MODELLING.
Dufresne-Henry, Inc., Westford, MA.
For primary bibliographic entry see Field 4B.
W91-03929

DELINEATION OF CONTRIBUTING AREAS TO PUBLIC SUPPLY WELLS IN STRATIFIED GLACIAL-DRIFT AQUIFERS.
Geological Survey, Marlborough, MA.
For primary bibliographic entry see Field 5G.
W91-03932

COMPUTERIZED DATA MANAGEMENT SYSTEM FOR WELLFIELD PROTECTION.
Pirnie (Malcolm), Inc., Columbus, OH.
For primary bibliographic entry see Field 5G.
W91-03939

GROUND WATER RESOURCE BASED MAPPING, NASHUA REGIONAL PLANNING AREA, NEW HAMPSHIRE.
Environmental Protection Agency, Boston, MA. Region I.
For primary bibliographic entry see Field 6A.
W91-03940

IGARSS '88. REMOTE SENSING: MOVING TOWARDS THE 21ST CENTURY.
Available from the National Technical Information Service, Springfield, Virginia 22161, as N89-18704. Price codes: A99 in paper copy, A01 in microfiche. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. 641p. Edited by T. D. Guyenne and J. J. Hunt.

Descriptors: *Data acquisition, *Plant water, *Remote sensing, *Satellite technology, *Soil water, *Water resources, Conferences, Instrumentation.

The application of remote sensing techniques to water resources issues is addressed in 23 articles included in a much larger collection of papers on remote sensing techniques. The papers were presented at the 1988 International Geoscience and Remote Sensing Symposium, held in September 1988 in Edinburgh, Scotland. Remote sensing techniques include radar, microwaves, and satellite imagery. Investigations covered include both laboratory studies and field studies, with many case histories. Topics include evaluation of soil and plant moisture content through remote sensing, estimation of suspended sediment and chlorophyll concentrations in bodies of water, calculations of lake area, estimates of snow cover, precipitation studies, slope stability investigations using remotely sensed data, hydrology studies, and other applications. Emphasis is on the cost-effective application of remote sensing technology to obtaining information on a regional scale, and solving data-collection and processing problems. (See W91-03944 thru W91-03967) (Tappert-PTT)
W91-03944

DATA PROCESSING FOR THE DETERMINATION OF PIGMENTS AND SUSPENDED SOLIDS FROM THEMATIC MAPPER DATA.
Freiburg Univ. (Germany, F.R.). Inst. for Physical Geography.
For primary bibliographic entry see Field 7B.
W91-03952

SATELLITE REMOTE SENSING FOR HYDROLOGICAL MONITORING AND WATER MANAGEMENT IN GREAT BRITAIN.
Bristol Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W91-03956

DIGITAL ELEVATION MODELS AND THEIR APPLICATION TO REMOTE SENSING OF WATER RESOURCES.
Aston Univ., Birmingham (England). Remote Sensing Unit.
J. D. Flach, and T. R. E. Chidley.
IN: IGARSS '88. Remote Sensing: Moving Towards the 21st Century. Proceedings of the 1988 International Geoscience and Remote Sensing Symposium, 12-16 September 1988, Edinburgh, Scotland. Volume III, August 1988. p 1545-1546. 3 ref.

Descriptors: *Computers, *Digital elevation models, *Mapping, *Model studies, *Remote sensing, *Stream classification, *Water resources management, Aerial surveys, Slopes, Water resources.

Since digital elevation models (DEMs) were first described in the late 1950's their main application has been in highway design packages, requiring mainframe computer resources and vector graphics terminals. More recently the advances in available, low-cost technology has brought the applications to a desk top level. DEMs can be generated by video digitizing or interpolation from the original survey data. Elevations can be displayed with shades of one color or different colors, providing much better representation of height than contours. Derived products include slope and aspect maps, shaded relief maps, geometric manipulation, catchment delineation, and stream orientation and order classification. This information has many applications in hydrology and water resource evaluation. (See also W91-03944) (Tappert-PTT)
W91-03959

MODELLING SHORT-TIMESCALE VARIATIONS IN RAIN-RATE.
Essex Univ., Colchester (England). Dept. of Mathematics.
For primary bibliographic entry see Field 2B.
W91-03960

MICROCOMPUTER-BASED RADIOMETER DATA ACQUISITION AND PROCESSING SYSTEM FOR LARGE-AREA MAPPING OF SOIL MOISTURE CONTENT IN THE TOP ONE METER LAYER.
Akademiya Nauk SSSR, Moscow. Inst. Radiotekhniki i Elektroniki.
For primary bibliographic entry see Field 7B.
W91-03963

PROPOSED MODEL FOR EVALUATING URBAN HYDROLOGIC CHANGE.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4C.
W91-03990

FINITE ELEMENT WATERSHED MODELING: ONE-DIMENSIONAL ELEMENTS.
Michigan State Univ., East Lansing. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W91-03993

GOAL-PROGRAMMING TECHNIQUES FOR OPTIMAL RESERVOIR OPERATIONS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W91-03994

EFFECT OF WIND ON THE DISTRIBUTION OF PHYTOPLANKTON CELLS IN LAKES.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
For primary bibliographic entry see Field 2H.
W91-03995

GAME-THEORETIC PARAMETER CONFIGURATION TECHNIQUE FOR AQUIFER RESTORATION DESIGN.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W91-04028

SIMULATION OF NONSTATIONARY, NON-GAUSSIAN WATER LEVELS ON GREAT LAKES.
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 2H.
W91-04070

ERROR ANALYSIS OF LIMITING-CASE SOLUTIONS TO THE STEADY-STATE-BIOFILM MODEL.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5D.
W91-04071

BETTER WATER QUALITY INDEXING SYSTEM FOR RIVERS AND STREAMS.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5G.
W91-04078

USE OF PRACTICAL ASPECTS OF SOIL BEHAVIOUR TO EVALUATE DIFFERENT METHODS TO GENERATE SOIL HYDRAULIC FUNCTIONS.
Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W91-04100

ROLE OF HYPSOMETRY AND PLANFORM IN BASIN HYDROLOGIC RESPONSE.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2E.
W91-04105

AUTOMATED MAPPING FOR ALABAMA SEWER SYSTEM.
BCM Engineers, Mobile, AL.
For primary bibliographic entry see Field 5D.
W91-04116

SET MEMBERSHIP APPROACH TO IDENTIFICATION AND PREDICTION OF LAKE EUTROPHICATION.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5C.
W91-04119

ANALYTICALLY DERIVED RUNOFF MODELS BASED ON RAINFALL POINT PROCESSES.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2E.
W91-04120

SOLUTION OF THE TRANSPORT EQUATION BY THE COLLOCATION METHOD IN CONJUNCTION WITH THE ADAPTIVE HERMITE ELEMENT FAMILY.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-04121

EVALUATION OF FIVE SIMULATION MODELS FOR PREDICTING ALDICARB AND BROMIDE BEHAVIOR UNDER FIELD CONDITIONS.
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-04122

CELL ANALYTICAL-NUMERICAL METHOD FOR SOLUTION OF THE ADVECTION-DISPERSION EQUATION: TWO-DIMENSIONAL PROBLEMS.
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-04124

DEVELOPMENT AND TESTING OF SINGLE-PARAMETER PRECIPITATION DISTRIBUTIONS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 2B.
W91-04126

HYBRID MODEL FOR FORECASTING DAILY RAINFALL.
Institute of Flood Control and Drainage Research, Dacca (Bangladesh).
For primary bibliographic entry see Field 2B.
W91-04127

IRON TRANSPORT AND DISTRIBUTION BETWEEN FRESHWATER AND SEDIMENTS OVER DIFFERENT TIME SCALES.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 2H.
W91-04154

CALIFORNIA WATER-USE GEOGRAPHIC INFORMATION SYSTEM.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04170

DATA MANAGEMENT TECHNIQUES FOR SITE-SPECIFIC WATER-USE DATA IN ARKANSAS.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04174

AGGREGATED WATER-USE DATA SYSTEM.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04181

DBASE III PLUS, YET ANOTHER DATA BASE FOR WATER-USE DATA.
Idaho Dept. of Water Resources, Boise.
For primary bibliographic entry see Field 6D.
W91-04182

U.S. GEOLOGICAL SURVEY'S NEW SITE-SPECIFIC WATER-USE DATA SYSTEM (NEWSWUDS).
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04183

KNOWLEDGE-BASED SYSTEMS FOR WATER RESOURCES MANAGEMENT.
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 6D.
W91-04184

SURFACE-WATER CONTAINMENT ROUTING USING A DIGITAL STREAM INFORMATION SYSTEM.
Geological Survey, Portland, OR.
For primary bibliographic entry see Field 5B.
W91-04185

USE OF GEOGRAPHIC INFORMATION SYSTEM FOR REAGGREGATING WATER-USE DATA FROM COUNTIES TO HYDROLOGIC UNITS.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 6D.
W91-04186

COLOR-GRAPHICS BASED WATER DEMAND FORECASTING MODEL.
Utah State Univ., Logan. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W91-04187

RELATIONAL DATABASE FOR NON-PROGRAMMERS.
Salt River Project, Phoenix, AZ. Data Base Div.
R. V. Bowen.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 233-238.

Descriptors: *Computer programs, *Data storage and retrieval, *Databases, *Information systems, *Water resources management, *Water use data, Computers, Groundwater resources, Surface water, Water resources data.

As concern over issues related to the quantity and quality of water continues to grow, there is a corresponding increase in the need for information, as well as for a method to manage it. This includes storing, organizing, manipulating and retrieving the data that will be used as the basis for decision making. The use of a computer offers the most efficient means of approaching this task. Decision makers often lack the programming skills necessary to manage the data on their own. This often requires the services of a programmer to operate the computer on behalf of the decision maker, or requires development of a system that would allow a computer novice to work on his own. It is the system approach which provides the most flexibility. By utilizing the programmers time to build a user friendly system, a non programmer can access information directly and obtain the precise information needed within the time required. This type of a system is now in use at the Salt River Project. It continues to provide many benefits to the employees that use it. With only a few minutes of training the user can access data from a variety of surface and groundwater data sets pertaining to water quality, well construction and pumping history. These are only a few of the areas where information is readily available to the user through a menu driven system which prompts for responses and provides on-line help. The system also provides the user with options on how to report the results of the query and offers the ability to calculate some descriptive statistics. (See also W91-04161) (Author's abstract)
W91-04188

GREAT LAKES REGIONAL WATER-USE DATA BASE--A WATER-RESOURCES MANAGEMENT TOOL.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04204

RELIABILITY IN MARKET TRANSFERS OF MUNICIPAL WATER SUPPLIES.
Colorado Coll., Colorado Springs. Dept. of Economics and Business.
For primary bibliographic entry see Field 6D.
W91-04220

ESTIMATION OF SURFACE-WATER WITHDRAWALS FOR IRRIGATION AND IRRIGATED ACREAGE, 1985, GALLATIN COUNTY, MONTANA.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 3F.
W91-04229

APPLICATION OF REMOTE SENSING AND GIS TO ESTIMATE IRRIGATION WATER USE IN THE UPPER GUNNISON RIVER BASIN IN COLORADO.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 3F.
W91-04233

ESTIMATION OF RESERVOIR SURFACE AREAS USING SATELLITE IMAGERY, UPPER GUNNISON RIVER BASIN, COLORADO.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 2D.
W91-04234

SPUDS FROM SPACE: USING REMOTE SENSING/GIS IN ADJUDICATING IDAHO WATER RIGHTS.
Idaho Dept. of Water Resources, Boise. Land and Water Use Data Section.
For primary bibliographic entry see Field 6E.
W91-04235

STATE WATER DEMAND METHODOLOGY, KANSAS, 1987.
Kansas Water Office, Topeka.
For primary bibliographic entry see Field 6D.
W91-04236

MAIN II-MODEL WATER-USE PROJECTIONS FOR WISCONSIN, 1990-2010.
Wisconsin Dept. of Natural Resources, Madison. Bureau of Water Resources Management.
For primary bibliographic entry see Field 6D.
W91-04238

ANALYSIS OF OBJECTIVE FUNCTIONS USED IN URBAN RUNOFF MODELS.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-04239

ANALYSIS OF THE VARIABLES AFFECTING WATER CONSUMPTION FOR THE CITY OF HAYS, KANSAS.
Missouri Univ.-Rolla. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W91-04240

NUMERICAL ANALYSIS OF COMPLEX PIPE SYSTEM WITH TWO PUMPS CONNECTED IN PARALLEL.
Bitola Univ. (Yugoslavia). Tehnicki Fakultet.
For primary bibliographic entry see Field 8A.
W91-04241

FORECASTING MUNICIPAL WATER DEMAND AND CONSERVATION EVALUATION: THE IWR-MAIN SYSTEM 5.1.
Planning and Management Consultants Ltd., Carbondale, IL.
For primary bibliographic entry see Field 6D.
W91-04242

UNCERTAINTY OF WATER SUPPLY DEMAND ESTIMATES.
Polytechnic Univ., Brooklyn, NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 6D.
W91-04243

WATER SUPPLY FORECASTING AND ITS UNCERTAINTIES.
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.
For primary bibliographic entry see Field 6D.
W91-04244

HYDROGEOLOGICAL MODEL FOR AMADEUS BASIN AQUIFERS, CENTRAL AUSTRALIA.
Birmingham Univ. (England). School of Earth Sciences.
For primary bibliographic entry see Field 2F.
W91-04273

COMPUTER SIMULATION OF TIDE-INDUCED RESIDUAL TRANSPORT IN A COASTAL LAGOON.
Harbor Branch Inst., Inc., Fort Pierce, FL.
For primary bibliographic entry see Field 2L.
W91-04295

NOTE ON THE ATTENUATION OF SURFACE GRAVITY WAVES BY RAINFALL.
Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W91-04298

NUMERICAL METHOD FOR PARAMETERIZATION OF ATMOSPHERIC CHEMISTRY: COMPUTATION OF TROPOSPHERIC OH.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
For primary bibliographic entry see Field 2K.
W91-04299

TROPOSPHERIC OH IN A THREE-DIMENSIONAL CHEMICAL TRACER MODEL: AN ASSESSMENT BASED ON OBSERVATIONS OF CH3CCL3.
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
For primary bibliographic entry see Field 5B.
W91-04300

SMOG-FOG-SMOG CYCLE AND ACID DEPOSITION.
California Inst. of Tech., Pasadena. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 2K.
W91-04301

ONE-DIMENSIONAL NUMERICAL MODEL TO SIMULATE FORMATION AND BALANCE OF SULFATE DURING RADIATION FOG EVENTS.
Munich Univ. (Germany, F.R.). Meteorologisches Inst.
For primary bibliographic entry see Field 2K.
W91-04302

SURFACE-BASED BEDLOAD TRANSPORT RELATION FOR GRAVEL RIVERS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2J.
W91-04304

METHODS TO CONVERT AMERICAN CLASS A-PAN AND SYMON'S TANK EVAPORATION TO THAT OF A REPRESENTATIVE ENVIRONMENT.
Hydrological Research Inst., Pretoria (South Africa).
For primary bibliographic entry see Field 2D.
W91-04314

COMBINED LONG-TERM SIMULATION OF RUNOFF FROM URBAN AND RURAL AREAS.
Addis Ababa Univ. (Ethiopia). Faculty of Technology.
For primary bibliographic entry see Field 5B.
W91-04333

COMPARISON OF POLLUTANT LOAD CALCULATION METHODS BASED ON MEASURED DATA--STATE OF THE INVESTIGATION.
Landesamt fuer Wasser und Abfall Nordrhein-Westfalen, Duesseldorf (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W91-04334

DEVELOPMENT, CALIBRATION AND FURTHER DATA REQUIREMENTS OF THE SEWER FLOW QUALITY MODEL MOSQITO.
Hydraulics Research Ltd., Wallingford (England).
For primary bibliographic entry see Field 5B.
W91-04335

DISSOLVED OXYGEN STREAM MODEL FOR COMBINED SEWER OVERFLOWS.
Aalborg Universitetscenter (Denmark). Hydraulics and Coastal Engineering Lab.
For primary bibliographic entry see Field 5C.
W91-04339

ASPECTS OF OZONE GENERATION FROM AIR.
Technische Hochschule Aachen (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W91-04380

MASS BALANCE ANALYSIS OF OZONE IN A CONVENTIONAL BUBBLE COLUMN.
Shanghai Coll. of Architecture and Municipal Engineering (China). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W91-04381

SOLUTE AND HEAT TRANSPORT EXPERIMENTS FOR ESTIMATING RECHARGE RATE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W91-04390

APPLICATION OF FACTOR ANALYSIS TO THE HYDROGEOCHEMICAL STUDY OF A COASTAL AQUIFER.
Alicante Univ. (Spain). Div. de Ingenieria Quimica.
For primary bibliographic entry see Field 2F.
W91-04397

EXAMINATION OF COMPUTED STEADY-STATE WATER-TABLE HEIGHTS IN UNCONFINED AQUIFERS: DUPUIT-FORCHHEIMER ESTIMATES AND EXACT ANALYTICAL RESULTS.
For primary bibliographic entry see Field 2F.
W91-04399

RELIABILITY BASED TIME AXES FOR FLOOD DATA PRESENTATION.
Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2E.
W91-04408

DO THE RIGHT THING.
For primary bibliographic entry see Field 6A.
W91-04409

TIME-DEPENDENT, THREE-DIMENSIONAL MODEL OF THE DELAWARE BAY AND RIVER SYSTEM: PART 1. DESCRIPTION OF THE MODEL AND TIDAL ANALYSIS.
Princeton Univ., NJ. Program in Atmospheric and Oceanic Sciences.
For primary bibliographic entry see Field 2L.
W91-04413

TIME-DEPENDENT, THREE-DIMENSIONAL MODEL OF THE DELAWARE BAY AND RIVER SYSTEM: PART 2. THREE-DIMENSIONAL FLOW FIELDS AND RESIDUAL CIRCULATION.
Princeton Univ., NJ. Program in Atmospheric and Oceanic Sciences.
For primary bibliographic entry see Field 2L.
W91-04414

DEFINING HOMOGENEOUS PRECIPITATION REGIONS BY MEANS OF PRINCIPAL COMPONENTS ANALYSIS.
Katholieke Univ. Leuven (Belgium). Lab. for Land Management.
For primary bibliographic entry see Field 2B.
W91-04435

GROUND-WATER WITHDRAWALS, WATER-LEVEL CHANGES, LAND-SURFACE SUBSIDENCE, AND GROUND-WATER QUALITY IN FORT BEND COUNTY, TEXAS, 1969-87.
Geological Survey, Austin, TX. Water Resources

Div.
For primary bibliographic entry see Field 4B.
W91-04467

HYDROGEOCHEMICAL DATA FROM AN ACIDIC DEPOSITION STUDY AT MCDONALDS BRANCH BASIN IN THE NEW JERSEY PINELANDS, 1983-86.
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04472

PRINCIPAL FACTS FOR GRAVITY STATIONS IN THE ELKO, STEPTOE VALLEY, COYOTE SPRING VALLEY, AND SHEEP RANGE AREAS, EASTERN AND SOUTHERN NEVADA.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-04473

BASE-FLOW INVESTIGATION ON THE SACRAMENTO RIVER, SEPTEMBER 25, 1985, NEAR SUNSPOT, OTERO COUNTY, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
C. Nagel.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-239, 1990. 1 sheet, 5 fig, 2 tab, 3 ref.

Descriptors: *Base flow, *New Mexico, *Sacramento River, *Water quality, Discharge measurement, Maps, Specific conductance, Surface water.

On September 25, 1985, the U.S. Geological Survey conducted a base-flow investigation to better define the surface-water resources of the Sacramento River drainage basin in Otero County, south-central New Mexico. The investigation included all flow in the Sacramento River from the initial point of flow to the point of zero flow 20.1 river miles downstream. A total of 12 discharge measurements, 3 observations of zero flow and 2 observations of initial flow were obtained during this investigation. Discharge measurements and observations showed a general increase in discharge from river mile 22.4 to a discharge of 6.69 cu ft/sec at river mile 8.4. Discharge then decreased from river mile 8.4 to zero flow at river mile 3.3. Specific conductance and water temperature also were taken concurrently with the discharge measurements. Specific conductance of water generally decreased in a downstream direction from 600 microsiemens/cm at 25 C at river mile 21.9 to 330 microsiemens/cm at 25C at river mile 4.6. (USGS)
W91-04475

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1989.
Geological Survey, Bow, NH. Water Resources Div.
K. E. McKenna, J. E. Cotton, and J. C. Denner.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-108290. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report NH-VT-89-1. (USGS/WRD/HD-90/295), 1990. 152p. Prepared in cooperation with the States of New Hampshire and Vermont and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Hampshire, *Surface water, *Vermont, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for New Hampshire and Vermont consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 72 gaging stations, stage records for 4 lakes, monthend contents for 23 lakes and reservoirs, water quality data for 2 gaging stations, and water levels for 28 observation wells. Also included are data for 7 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Locations of gaging stations, partial-record stations, and observation wells are shown. A few pertinent stations (not included above) in bordering States and Province of Quebec are also included. These data represent that portion of the National Water Data System collected by the U.S. Geological Survey and by the cooperating State and Federal agencies in New Hampshire and Vermont. (See also W90-11233) (USGS)
W91-04480

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1989.
Geological Survey, Bismarck, ND. Water Resources Div.
R. E. Harkness, N. D. Haffield, and W. R. Berkas.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-106989. Price codes: A17 in paper copy, A03 in microfiche. USGS Water-Data Report ND-89-1. (USGS/WRD/HD-90/270), 1990. 386p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Drought, Floods, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for North Dakota consist of records of discharge, stage, and water quality for streams; contents, stage and water quality for lakes and reservoirs; and water levels and water quality for groundwater wells. The report contains records of water discharge for 108 streamflow gaging stations; stage only for 22 river-stage stations; contents and/or stage for 13 lake or reservoir stations; annual maximum discharge for 8 crest-stage stations; water levels for 30 groundwater wells; and water quality for 97 streamflow gaging stations, 4 river-stage stations, 10 lake or reservoir stations, 5 crest-stage stations, and 29 groundwater wells. Also included are discharge measurement data for 131 miscellaneous sites and water quality data for 2 precipitation-chemistry stations. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in North Dakota. (USGS)
W91-04481

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1989, VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, W. J. Shelby, and H. J. Davidson.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-268566. Price codes: A22 in paper copy, A03 in microfiche. USGS Water-Data Report TX-89-1. (USGS/WRD/HD-90/291), 1990. 499p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1989 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States also are included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See also W91-02639 and W91-02640) (USGS)
W91-04482

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1989.
Geological Survey, Charleston, WV. Water Resources Div.
S. M. Ward, J. A. Macy, F. M. Taylor, and G. M. Ferrell.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-108530. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report WV-89-1. (USGS/WRD/HD-90/308), 1990. 169p. Prepared in cooperation with the State of West Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *West Virginia, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1989 water year for West Virginia consist of records of stage, discharge, and water quality of streams; contents of reservoirs; and water levels of observation wells. This report contains discharge records for 81 streamflow-gaging stations; stage only records for 7 gaging stations; annual maximum discharge at 2 crest-stage partial-record stations; change in contents for 1 reservoir; water quality records for 14 streamflow gaging stations; and water level records for 31 observation wells. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (See also W91-01858) (USGS)
W91-04483

SOIL TEMPERATURE UNDER CONVENTIONAL AND MINIMUM TILLAGE: SIMULATION AND EXPERIMENTAL VERIFICATION.
Alberta Univ., Edmonton. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-04582

RELATIONSHIPS BETWEEN SOME PROPERTIES OF ORGANIC SOILS FROM THE SOUTHERN CANADIAN SHIELD.
Ottawa Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W91-04583

CLASSIFICATION OF TEXAS RESERVOIRS IN RELATION TO LIMNOLOGY AND FISH COMMUNITY ASSOCIATIONS.
Texas Parks and Wildlife Dept., Austin. Inland Fisheries Branch.
For primary bibliographic entry see Field 2H.
W91-04591

SPREADSHEETS FOR ESTIMATING SLUDGE PRODUCTION.
Greeley and Hansen, Philadelphia, PA.
C. M. Koch, A. Cevallos, J. Pascucci, and G. Lindner.
Water Environment & Technology WAETEJ, Vol. 2, No. 11, p 65-69, November 1990.

Descriptors: *Computer models, *Data processing, *Sludge, *Spreadsheets, *Wastewater facilities, Activated sludge process, New Jersey, New York, Predictive models.

Estimation of sludge quantities requires knowledge of the wastewater flow and strength, the operating conditions of the activated-sludge process, and the number of processing units in service. Computer spreadsheets were used to predict sludge generation for three wastewater treatment plants: the Camden County Municipal Utilities Authority's (CCMUA) Delaware No. 1 Water Pollution Control Facility (DWPCF); and the Bay Park and Cedar Creek Water Pollution Control Plants in Nassau County, N.Y. The basic approach was to develop models of the various unit processes to relate primary and secondary sludge production to wastewater strength and operating conditions. The models were fitted to either pilot-plant data or actual plant operation data to calibrate the models to the individual treatment plants. The models were then used to determine net quantities of primary and secondary sludge produced. These quantities were then traced through the wastewater process to account for solids destruction by processes such as anaerobic digestion and the effects of recycle streams. The spreadsheet was used to predict future sludge quantities. The spreadsheet was organized into four primary regions: (1) title information and printing macros; (2) adjustable variables; (3) computed values; and (4) a process flow schematic. Although there was some variation between observed and predicted values, this type of variation is to be expected when attempting to model a complex biological process. (White-Reimer-PTT)
W91-04603

SIMPLE CONTOURING PROGRAM FOR GRIDDED DATA.
Geological Survey, Reston, VA.
A. W. Harbaugh.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, CO 80225-0425. USGS Open-File Report 90-144, 1990. 37p, 5 fig, 3 ref, append.

Descriptors: *Computer programs, *Contours, *Data interpretation, *Data processing, *Gridded data, *Mapping, Computers, Handbooks, Manuals.

A computer program was developed which contours a two-dimensional array of data has been developed. This report documents the contouring method and program design, and provides user instructions. The two-dimensional array contains Z values for each node in a grid, and the grid dimensions define the (X,Y) coordinates for each node. Branches connect adjacent nodes vertically and horizontally. A contour line is formed by connecting successive contour points with straight lines. Contour points occur only on branches. If the value being contoured is between the Z values at two adjacent nodes, the connecting branch contains a contour point. Linear interpolation is used to find the location of a contour point on a branch. The program is written in the FORTRAN programming language, and it uses Graphics Kernel System (GKS) subroutine calls. (Author's abstract)
W91-04638

FLOOD OF APRIL 4-5, 1987, IN SOUTHEASTERN NEW YORK STATE, WITH FLOOD PROFILES OF SCHOHARIE CREEK.
Geological Survey, Albany, NY.
For primary bibliographic entry see Field 2E.
W91-04645

PHARMACOKINETIC MODELING IN AQUATIC ANIMALS: I. MODELS AND CONCEPTS.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
For primary bibliographic entry see Field 5B.
W91-04733

RARE BRITISH MARINE FISHES--IDENTIFICATION AND CONSERVATION.
Marine Biological Association of the United Kingdom, Plymouth (England).
For primary bibliographic entry see Field 8I.
W91-04787

MAPS OF FLOOD STATISTICS FOR REGIONAL FLOOD FREQUENCY ANALYSIS IN NEW ZEALAND.
Department of Scientific and Industrial Research, Christchurch (New Zealand). Hydrology Centre.
For primary bibliographic entry see Field 2E.
W91-04802

RIVER FLOW FORECASTING SYSTEM WITH DATA MANAGEMENT, GRAPHICAL RIVER NETWORK CONTROL AND INTERACTIVE OPERATION.
Uppsala Univ. (Sweden). Dept. of Hydrology.
For primary bibliographic entry see Field 2E.
W91-04804

COMPARISON OF CAPILLARY PRESSURE--SATURATION RELATIONS FOR DRAINAGE IN TWO-AND THREE-FLUID POROUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 2F.
W91-04825

PARALLEL COMPUTING FOR SOLUTE TRANSPORT MODELS VIA ALTERNATING DIRECTION COLLOCATION.
Wyoming Univ., Laramie. Dept. of Mathematics.
For primary bibliographic entry see Field 5B.
W91-04826

MODERN KRIGING AND CLASSICAL GAUSSIAN TECHNIQUES--DO THEY NECESSARILY YIELD IDENTICAL RESULTS.
Grenoble-1 Univ. (France).
For primary bibliographic entry see Field 2G.
W91-04829

SURVEY OF VECTOR AND PARALLEL PROCESSORS FOR NUMERICAL APPLICATIONS.
SARA, Amsterdam (Netherlands).
A. Emmen.
Advances in Water Resources AWREDI, Vol. 13, No. 3, p 103-116, 1990. 12 fig, 9 tab, 41 ref.

Descriptors: *Computers, *Data processing, *Mathematical analysis, *Parallel processing, *Supercomputers, *Vector processing, Graphics, Minisupercomputers.

The speed of computers for numerical applications has been largely enhanced over the last decade largely due to the use of new computer architectures, using vector and parallel processing. An overview of most of the available computers is presented along with descriptions of the largest supercomputers. A computer for numerical applications must have: (1) a floating-point processor with adequate word size to fulfill accuracy requirements; (2) enough speed to perform the calculations within a reasonable length of time; (3) a large, high speed memory; and (4) a suitable operating system and a compiler for program development and execution. Vector and parallel computers are designed for applications that do not fit on a single unsegmented processor. For vector processors there is a relation between the application and the amount of segmentation. For parallel computers the amount and kind of parallelization in the machine must also be related to the amount and level of parallelism available in the application. Computers that are reviewed include supercomputers (the most powerful, general purpose machines available); minisupercomputers (deliver approximately 10% of the performance of a supercomputer); mainframes with integrated vector processors; graphic supercomputers (for workstation interface); and special purpose parallel machines. The overview indicates that there are a large number of vector and parallel machines to choose from, and there is no one simple architectural solution that fits the needs of numerically intensive calculations. Vector processing is now a mature technique incorporated even in quite a number of parallel machines; however, the latest designs show less of special vector processing hardware even though the perform fast on 'vector code.' The diversity of architecture makes it as yet impossible to easily identify the performance of different machines. (White-Reimer-PTT)
W91-04830

SURVEY OF DOMAIN DECOMPOSITION TECHNIQUES AND THEIR IMPLEMENTATION.
Wyoming Univ., Laramie. Dept. of Mathematics.
For primary bibliographic entry see Field 2G.
W91-04831

PARALLEL LEAST SQUARES COLLOCATION CONJUGATE GRADIENT APPROACH FOR THE ADVECTION DIFFUSION EQUATION.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
A. Peters, and G. F. Pinder.
Advances in Water Resources AWREDI, Vol. 13, No. 3, p 126-136, 1990. 14 fig, 28 ref, append. DOE grant DE-FG02-86ER60453.

Descriptors: *Advection-diffusion, *Computers, *Data processing, *Mathematical analysis, *Model studies, *Parallel processing, *Path of pollutants, *Solute transport, Advection diffusion equation, Domain decomposition, Least squares method, Preconditioned conjugate gradient.

Most existing programs for the solution of the advection diffusion equation are tailored to suit the hardware of conventional computers and are likely to achieve very modest performance enhancements on vector and parallel processors. Therefore, an alternative approach for the solution of the advective diffusion equation over irregular shaped domains was developed. The approach, termed LSCCG, combines the least squares collocation algorithm and a patch domain decomposition technique with the powerful conjugate gradient method. LSCCG provides accurate results for a large range of Peclet and Courant numbers. In addition, it is amenable to parallelization at either the subroutine or loop level, and thus easy to implement on a large variety of computer architectures. Some of the most appealing features of this approach are: (1) it leads to a system of equations where the coefficient matrix is symmetric, and sparse; (2) irregularly shaped domains can be accurately described using orthogonal meshes and additional set of collocation points; (3) the orthogonality of the grid enables the design of a very simple data structure free of indirect indexing and the easy implementation of patch refinements; (4) the simplicity of the data structure makes possible the parallel implementation of all time consuming computational tasks of the preconditioned conjugate gradient method, including those of the incomplete Cholesky preconditioning; and (5) the preconditioned conjugate gradient method is very powerful when applied to the system of linear equations resulting from the least squares collocation approximation of the advection diffusion equation. (Author's abstract)
W91-04832

ITERATIVE METHODS FOR THE SOLUTION OF LARGE SYSTEMS OF EQUATIONS ON SUPERCOMPUTERS.
Utrecht Rijksuniversiteit (Netherlands). Mahematical Inst.
H. van der Vorst.
Advances in Water Resources AWREDI, Vol. 13, No. 3, p 137-146, 1990. 2 fig, 2 tab, 53 ref.

Descriptors: *Computers, *Data processing, *Iterative methods, *Mathematical equations, *Model studies, Conjugate gradient method, Linear systems, Preconditioners.

The choice for solving large sparse linear systems of equations is between direct and iterative methods. Direct methods have the advantage of being robust and not having criteria or non-convergence problems. Iterative methods have the advantage of being relatively easy to code, adapt easily to changes in the underlying physical model, require only a modest amount of computer memory storage and take little computer time per iteration step.

The most successful modern iterative methods are discussed including the conjugate gradients (CG) method, GMRES and conjugate gradients-squared (CG-S). For positive definite symmetric systems the choice is clearly CG, for other systems GMRES and CGS are the candidates because they are among the fastest methods for many sparse nonsymmetric linear systems. The effectiveness of these methods is often dramatically improved by preconditioning. Preconditioning comes down to identifying a neighboring linear system which can be solved very cheaply. The matrix of this neighboring system is used to convert the given linear system to a system with favorable properties with respect to the convergence of the iterative method. Large scale scientific computational models are generally solved by means of supercomputers such as CRAY, X-MP, CRAY, Y-MP, CONVEX C-series, Alliant FX-series, IBM 3090-VF-models and many others. (White-Reimer-PTT)
W91-04833

IS A SIMPLE DIAGONAL SCALING THE BEST PRECONDITIONER FOR CONJUGATE GRADIENTS ON SUPERCOMPUTERS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
G. Pini, and G. Gambolati.
Advances in Water Resources AWREDI, Vol. 13, No. 3, p 147-153, 1990. 1 fig, 4 tab, 52 ref.

Descriptors: *Computers, *Data processing, *Mathematical models, *Model studies, *Supercomputers, Conjugate gradient method, Least squares method, Linear systems, Preconditioners, Vector processing.

The implementation of accelerated conjugated gradients for the solution of large sparse systems of linear equations on vector/parallel processors requires programming features which are significantly different from the one needed on a scalar machine. A numerical algorithm which works well on the scalar machine may be largely inefficient on the vector/parallel processor. Therefore, the numerical performances on a CRAY X-MP/48 of some widely known preconditioning techniques, including diagonal scaling, the incomplete Cholesky decomposition and the least squares polynomial preconditioners were compared. The ones that are not suited to scalar machines appear to be particularly attractive from a conceptual view point on vector/parallel architectures. The results obtained with 12 arbitrarily sparse finite element problems of growing size up to almost 5000, show surprisingly that simple diagonal scaling is the most efficient preconditioning scheme in the majority of applications. In the few cases where it was not the most efficient, its performance was nevertheless comparable with that of the incomplete Cholesky factorization. Contrary to the general expectation, the polynomials exhibit a poor performance which does not increase with the degree and appear never to be competitive with the other two more traditional approaches. (Author's abstract)
W91-04834

STABILITY ANALYSIS OF A TWO-INLET BAY SYSTEM.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL. Div. of Applied Marine Physics.
For primary bibliographic entry see Field 2L.
W91-04836

HYDROGEOLOGY OF THE MORRISON FORMATION IN THE SAN JUAN STRUCTURAL BASIN, NEW MEXICO, COLORADO, ARIZONA AND UTAH.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04853

HYDROLOGIC FRAMEWORK OF LONG ISLAND, NEW YORK.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-04854

DATA ON POLYCHLORINATED BIPHENYLS, DIELDRIN, LEAD, AND CADMIUM IN WISCONSIN AND UPPER MICHIGAN TRIBUTARIES TO GREEN BAY, JULY 1987 THROUGH APRIL 1988.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-04861

SUMMARY OF SELECTED CHARACTERISTICS OF LARGE RESERVOIRS IN THE UNITED STATES AND PUERTO RICO, 1988.
Geological Survey, Denver, CO. Water Resources Div.
B. C. Ruddy, and K. J. Hitt.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-163, 1990. 295p, 3 fig, 3 tab, 8 ref. Project No. C0183.

Descriptors: *Lake morphometry, *Reservoir capacity, *Reservoirs, *Water resources data, Data collections, Surface areas.

This report presents selected characteristics of 2,728 reservoirs and controlled natural lakes located within the 50 States of the United States and the Commonwealth of Puerto Rico. Data are presented for reservoirs that have normal capacities of at least 5,000 acre-ft or maximum capacities of at least 25,000 acre-ft and that were completed as of January 1, 1988. Reservoir data include: location, maximum capacity, normal capacity, surface area, drainage area, year completed, and use. The normal capacities of the 2,728 reservoirs and controlled natural lakes total more than 467 million acre-ft, and the combined surface areas for 2,362 of those reservoirs total almost 16 million acres. More than 9% (259) of the reservoirs are located in California. The total normal capacity of reservoirs in California is more than 40 million acre-ft (about 8.6% of the total normal capacity for the United States and Puerto Rico), and the total surface area is almost 700,000 acres (about 4.4% of the listed total surface area for the United States and Puerto Rico). (USGS)
W91-04862

RECORDS OF WELLS AND CHEMICAL ANALYSES OF GROUND WATER IN DEUEL AND HAMLIN COUNTIES, SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
K. M. Neitzert, and D. S. Hansen.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-391, 1990. 113p, 2 fig, 3 tab, 24 ref.

Descriptors: *Groundwater resources, *Hydrologic data, *South Dakota, *Water resources data, *Well data, Data collections, Deuel County, Hamlin County, Water quality.

Well and chemical groundwater data contained in three tables were collected during a 5-year study started in 1971 to determine the geology and water resources of Deuel and Hamlin Counties, South Dakota. Physical, hydrologic, and geologic data for 3,228 wells and test holes have been entered into computer storage in the Ground-Water Site Inventory File of the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). The well tables in the report are computer printouts from WATSTORE. Water quality data from 564 chemical analyses have been stored in the Water-Quality File of WATSTORE and is computer printed in the chemical analyses table by aquifer. (USGS)
W91-04865

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1988.
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Hauth, D. M. Walters, T. E. Coffey, and D. K. White.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-106807. Price codes: A15 in paper copy, A02 in microfiche. USGS Water-Data Report OK-88-1. (USGS/WRD/HD-90/299), 1990. 326p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oklahoma, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water temperature.

Water resources data for the 1988 water year for Oklahoma consists of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes or reservoirs. This report contains discharge records for 126 gaging stations; stage and contents for 30 lakes or reservoirs; water quality for 39 gaging stations and 2 lakes. Also included are 23 partial-record stations. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (USGS)
W91-04868

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1989.
Geological Survey, Madison, WI. Water Resources Div.
B. K. Holmstrom, and R. M. Erickson.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-105106. Price codes A19 in paper copy, A03 in microfiche. USGS Water-Data Report WI-89-1. (USGS/WRD/HD-90/298), 1990. 436p. Prepared in cooperation with the State of Wisconsin and with other agencies.

Descriptors: *Acid rain, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wisconsin, Chemical analysis, Flow rates, Gaging stations, Lakes, Microbiological studies, Reservoirs, Sediments, Water level.

Water resources data for the 1989 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface and groundwater. Records of chemical analysis of precipitation, surface and groundwater associated with acid deposition are included. In addition water levels in observation wells are reported. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and local agencies and for other Federal agencies in Wisconsin. (USGS)
W91-04869

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1989.
Geological Survey, Carson City, NV. Water Resources Div.
A. Pupacko, L. C. VanGordon, R. P. Collins, and J. R. Swartwood.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-109647. Price codes: A15 in paper copy, A02 in microfiche. USGS Water-Data Report NV-89-1. (USGS/WRD/HD-90/309), 1990. 3 d in cooperation with several Federal, State, and local agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nevada, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Water wells.

Water resources data published for the 1989 water year for Nevada comprise the following records: Water discharge for 122 gaging stations on streams, canals, and drains; (2) Discharge data for 101 peak-flow stations and miscellaneous sites, and 47 springs; (3) Stage and contents for 23 lakes and reservoirs; (4) Precipitation totals for 16 stations;

(5) Water levels for 22 continuous record wells, and 376 observation wells; (6) Water quality data for 36 stream, canal, and drain sites, and 18 wells. Additional water data, collected at various sites that are not part of the systematic data collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nevada. (USGS)
W91-04877

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1989, VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-108514. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report PA-89-3. (USGS/WRD/HD-90/311), 1990. 169p. Prepared in cooperation with State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Water wells.

Water resources data for the 1989 water year for Pennsylvania consist of records of discharge and water quality of stream; contents and elevations of lakes and reservoirs; and water levels of groundwater wells. This report, Volume 3, includes records from the Ohio and St. Lawrence River basins. Specifically, it contains: (1) discharge records for 81 continuous record streamflow-gaging stations and 41 partial-record stations; (2) elevation and contents records for 3 lakes and reservoirs; (3) water quality records for 6 streamflow-gaging stations, for 11 ungaged streamsites; and (4) water level records for 20 network observation wells. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volume 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Local, and Federal agencies in Pennsylvania. (USGS)
W91-04878

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1989. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
R. H. Nakahara, M. G. H. S. Lum, I. Yamashiro, G. A. Tateishi, and V. E. Kunishige.
Available from the National Technical Information Service, Springfield, VA 22161 as PB91-129031. Price codes: A14 in paper copy, A02 in microfiche. USGS Water-Data Report HI-89-1 (WRD/HD-90-314), 1990. 302p. Prepared in cooperation with the State of Hawaii and other agencies.

Descriptors: *Data collections, *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, volume 1, contains discharge records for 82 gaging stations; water quality for 14 gaging stations, 65 partial-record flow stations, and 138 wells; and water levels for 35 observation wells. Also included are 107 crest-stage partiial record stations, 25 miscellaneous partial-record sites, and 6 low-flow partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal and other agencies in Hawaii. (See also W90-05265) (USGS)
W91-04903

WATER RESOURCES DATA ARIZONA, WATER YEAR 1989.
Geological Survey, Tucson, AZ.
F. C. Boner, C. F. Smith, W. B. Garrett, and A. Konieczki.
Available from the National Technical Information Service, Springfield, VA 22161 as PB91-119271. Price codes: A17 in paper copy, A03 in microfiche. USGS Water-Data Report AZ-89-1 (WRD/HD-90/307), 1990. 383p. Prepared in cooperation with the State of Arizona and other agencies.

Descriptors: *Arizona, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents, water quality of lakes and reservoirs; water levels of observation wells; and quality of groundwater. This report contains discharge records for 179 gaging stations, annual peaks for 25 crest-stage partial-record stations, and discharge measurements at 7 miscellaneous sites; contents only records for 9 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 20 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 41 continuous-record stations and 6 miscellaneous sites; water levels for 1,274 observation wells; and water quality data for water from 276 wells. The data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Federal and State Agencies in Arizona. (See also W90-06279) (USGS)
W91-04904

DECISION SUPPORT FOR BEST MANAGEMENT PRACTICE SELECTION.
Purdue Univ., Lafayette, IN. Water Resources Research Center.
For primary bibliographic entry see Field 6A.
W91-04905

TRIANGULAR FINITE VOLUME APPROACH WITH HIGH-RESOLUTION UPWIND TERMS FOR THE SOLUTION OF GROUNDWATER TRANSPORT EQUATIONS.
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-04915

SERIES REPRESENTATION OF FLUX FOR THE BOUSSINESQ EQUATION.
Thessaloniki Univ., Salonika (Greece). Faculty of Engineering.
For primary bibliographic entry see Field 2F.
W91-04916

ERROR ANALYSIS AND STOCHASTIC DIFFERENTIABILITY IN SUBSURFACE FLOW MODELING.
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 2F.
W91-04918

APPROXIMATE ANALYTICAL SOLUTIONS FOR OVERLAND FLOWS.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-04919

IDENTIFIABILITY OF CONCEPTUAL HYDROCHEMICAL MODELS.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-04927

LINKING HYDROLOGICAL, GEOCHEMICAL, AND SOIL CHEMICAL PROCESSES ON THE CATCHMENT SCALE: AN INTERPLAY BETWEEN MODELING AND FIELD WORK.
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 2A.
W91-04935

8. ENGINEERING WORKS

8A. Structures

OPTIMAL UPGRADING OF HYDRAULIC-NETWORK RELIABILITY.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
L. Ormsbee, and A. Kessler.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 6, p 784-802, November/December 1990. 7 fig, 7 tab, 15 ref.

Descriptors: *Cost analysis, *District of Columbia, *Hydraulic geometry, *Linear programming, *Network design, *Systems analysis, *Topology, *Water mains, Hydraulic design, Pipelines, System redundancy.

A least-cost methodology is presented for use in upgrading existing single-source water distribution network to sustain any single component failure (link or node). The methodology is developed by casting the network reliability problem in terms of an explicit level of system redundancy. As a result, minimum cut set computations are avoided as well as the need to select an arbitrary level of system reliability. The design engineer can select a design based on the total cost and the desired level of service. The proposed methodology results in a network that provides two different levels of system redundancy: topologic and hydraulic. Topologic redundancy is satisfied through the application of methods from graph theory, while hydraulic redundancy is satisfied through the application of linear programming. The Federally Owned Water Main (FOWM) System transmission-and-distribution system in Washington, D.C. contains approximately 25 miles of water main, laid in the 1930s and 1940s. The average-day demand for FOWM is approximately 3,200,000 gallons. Separate level-one redundant systems were developed for three different loading conditions: maximum day demand, peak-hour demand, and maximum day plus fire flow. The first step is the construction of a two-node-connected graph, which would necessitate the addition of three new pipelines. The next step is to decompose the network into two overlapping spanning trees (graphs that connect all junction nodes, whose elements are selected from the original network such that the resulting graphs contain no loops). Once the topological redundancy has been established, the hydraulic redundancy must be ensured, at the minimum cost, by solving a linear program that simultaneously considers individual head constraints for both spanning trees. Programs are solved for each set of loading conditions, and can be plotted on a single graph. (Brunone-PTT)
W91-03992

NUMERICAL ANALYSIS OF COMPLEX PIPE SYSTEM WITH TWO PUMPS CONNECTED IN PARALLEL.
Bitola Univ. (Yugoslavia). Tehnicki Fakultet.
L. F. Stojanovski, V. D. Stojanovski, and S. D. Panovski.
IN: Water-Use Data for Water Resources Management. Proceedings of a Symposium. American Water Resources Association, Bethesda, Maryland. 1988. p 773-786, 2 fig, 3 ref.

Field 8—ENGINEERING WORKS

Group 8A—Structures

Descriptors: *Data interpretation, *Mathematical analysis, *Pipelines, *Pumps, *Water conveyance, *Water use data, Computer programs, Graphical analysis, Mathematical studies, Water supply, Yugoslavia.

A complete numerical analysis was developed for a system consisting of two parallel pipelines, each of which is fitted with a pump and which are then connected to a serial pipeline. This problem frequently arises in practice, for example (in industrial plants and in the acquisition of water for populated areas. This analysis can be used to solve 10 other situations (included in the analysis, such as the non-existence of one or both parallel pipes, and various combinations of gravitational-pump pipelines, etc.). The program that represents the numerical analysis graphically and analytically provides the working points of the system, i.e., it determines the quantity of water transported to the consumer and the power used by the pumps. It is written in Pascal (v. 4.0) and can be run on any IBM compatible computer. (See also W91-04161) (Author's abstract)
W91-04241

CONSTANT DISCHARGE DEVICE FOR FIELD IRRIGATION.
Karlsruhe Univ. (Germany, F.R.).
For primary bibliographic entry see Field 3F.
W91-04307

COMPARISON OF OVERFLOWS FROM SEPARATE AND COMBINED SEWERS--QUANTITY AND QUALITY.
University of Technology Sydney, Broadway (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04326

STUDY OF TRASH AND TRASH INTERCEPTION DEVICES.
University of Technology Sydney, Broadway (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04359

POST-TENSIONING MULLARDOCH DAM IN SCOTLAND.
Halcrow (William) and Partners, Swindon (England).
J. L. Hinks, J. W. Burton, A. R. Peacock, and E. M. Gosschalk.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 11, p 12-15, November 1990. 6 fig, 6 ref.

Descriptors: *Dam repair, *Dam stability, *Dams, *Leakage, *Maintenance, *Post-tensioning, *Scotland, Concrete dams, Cracks, Dam failure, Gravity dams, Grouting, Model studies, Mullardoch Dam, Tendons.

The Mullardoch dam in Scotland is a 40-yr-old concrete gravity dam 50 m high and 730 m long. In July 1986 there was a sudden increase in leakage associated with widening and extension of horizontal cracks between the inspection gallery and the upstream face of the dam. The cracking was evident mainly in the two blocks on either side of the central buttress separating the two flanks of the dam. The solution was to post-tension the central four blocks of the dam using 26 vertical tendons. Transverse tendons also were installed to counteract induced tensions above the roof of the inspection gallery. A three-dimensional modeling program known as ASAS was employed to simulate the main horizontal crack by disconnecting nodes on either side of the crack. Care was needed to identify any negative crack widths, because these would have yielded unrealistic displacement and stresses. One of the objects of the post-tensioning work was to force closure of the horizontal cracks, and it was felt that this might be difficult if grout and drilling debris were allowed to fill the cracks prior to stressing. Compressible foaming grout was used to fill the cracks prior to stressing. Although the cracks typically closed by 0.2-0.8 mm, which was disappointing, they were satisfactorily watertight upon filling of the reservoir. Post-tensioning at Mullardoch appears to have provided a cost-effective solution to a difficult problem and continued satisfactory performance is expected. The system used allows for regular monitoring of loads in the tendons using a screw-on hydraulic load cell. (Rochester-PTT)
W91-04425

REPAIRS TO THE MARTIN GONZALO DAM.
Strabag Bau S.A., Madrid (Spain).
W. Flemme, J. A. Baztan, and E. Funk.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 11, p 16-20, November 1990. 6 fig.

Descriptors: *Asphalt membranes, *Dam repair, *Leakage, *Maintenance, *Spain, Construction methods, Cracks, Earth dams, Martin Gonzalo Dam, Model studies.

An asphaltic membrane was used to repair the Martin Gonzalo dam, in the province of Cordoba, Spain. Leakage had occurred as a result of cracking caused by settlement. The membrane needed a high deforming capacity along with adequate stability for use on a 1:1.5 slope. Model studies were employed to explain the leakage and develop a satisfactory remedy. The effects of loading were observed in the model, instrumentation was designed based on the model, and different materials were tested in the laboratory. The original plan was to place the asphalt blanket in a single stage. Because the repair work extended into autumn, when flood risk increases in this area, only the binder layers were placed initially and the toe connection was extended. This created a reservoir capacity of 4 million cum m without endangering the structure. The asphalt was placed on the slope in lanes from toe to top, followed by leveling, compacting, and spraying the slope with cationic emulsion at a rate of 1.5 kg/sq m. Two methods of compaction were employed. A fine mastic layer was applied to protect against ultraviolet light. The reservoir reached its design level early in 1990 and has been behaving satisfactorily as predicted. (Rochester-PTT)
W91-04426

SEALING EARTHEN HYDRAULIC STRUCTURES WITH ENHANCED GLEIZATION AND SODIUM CARBONATE: I. LABORATORY STUDY OF THE EFFECT OF A FREEZE-THAW CYCLE AND A DRYING INTERVAL.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
For primary bibliographic entry see Field 8G.
W91-04543

SEALING EARTHEN HYDRAULIC STRUCTURES WITH ENHANCED GLEIZATION AND SODIUM CARBONATE: II. APPLICATION FOR LINING AN IRRIGATION CANAL.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
For primary bibliographic entry see Field 8G.
W91-04544

MECHANICAL AND ELECTRICAL EQUIPMENT FOR COLOMBIA'S GUAVIO PROJECT.
Ingetec S.A., Bogota (Colombia).
For primary bibliographic entry see Field 8C.
W91-04807

DESIGN FEATURES OF VENEZUELA'S MACAGUA II SCHEME.
EDELCA, Caracas (Venezuela).
For primary bibliographic entry see Field 8C.
W91-04808

PLANNING HYDROELECTRIC DEVELOPMENTS IN ARGENTINA.
Acquasolum S.A., Buenos Aires (Argentina).
E. G. Aisiks.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 12, p 22-26, 28-30, 32-34, December 1990. 8 fig, 3 tab, 3 ref.

Descriptors: *Argentina, *Energy sources, *Hydroelectric plants, *Optimum development plans, *Planning, *Project planning, *Resources development, Future planning, Hydroelectric power, Regional development, Water resources development.

Argentina's energy resources are abundant and diverse. They include hydropower, natural gas and oil, as well as smaller amounts of coal and uranium. About two-thirds of the country is arid or semi-arid, and requires very careful management of its water resources. This results from the uneven geographical distribution of the mean annual precipitation over the country, which ranges from more than 1500 mm in the northeast to less than 200 mm in the southwest. The rational use of hydroelectric potential requires careful planning. The availability of other energy resources, such as fossil fuels, requiring lower initial investments, makes it difficult to balance adequately the various types of generation for the electricity system. A planning methodology has been developed under the auspices of the Directorate of Planning of the Secretariat of Energy, with the participation of professionals from the various power companies and private consultants. The planning procedure uses various models that cover the following basic steps: preliminary selection of the generating equipment; simulation of the selected equipment operation by a load dispatching model; verification of service quality, reliability and costs of the selected system equipment; verification of operating conditions during critical hydrological periods; selection of the required transmission equipment; and verification of service quality, reliability and costs of the transmission system selected. The availability of the planning methodology will help in evaluating and guiding the trend of investments, either public or private, in the power sector. The comparative economic advantages of the hydro projects in the long-term, as well as their positive environmental impact, will probably enhance its chances of development. (Mertz-PTT)
W91-04809

ENSURING THE DYNAMIC STABILITY OF SESQUILE DAM IN COLUMBIA.
Ingetec S.A., Bogota (Colombia).
A. Marulanda, F. Amaya, and J. N. Gomez.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 12, p 42-53, December 1990. 15 fig, 7 ref.

Descriptors: *Colombia, *Dam construction, *Dam stability, *Earthquakes, *Seismic properties, *Sesquile Dam, Check dams, Dam failure, Dam foundations, Dams, Liquefaction, Reservoirs, Water level.

Measures taken to ensure the stability of Sesquile dam in Colombia in the event of an earthquake are examined. It had been feared that the foundation material could liquefy. A seismic stability evaluation of the Sesquile dam was carried out in 1974. Several remedial measures were analyzed either to increase the relative density of the fill to a value of 80%, or to increase the stability of the dam, restraining the effects of liquefaction. The alternative chosen to ensure the dynamic stability of the dam was to restrain the sliding movement of the whole dam in the event of liquefaction; this was achieved by confining its shells with two stabilizing berms. In the downstream berm it was necessary to densify its foundation first, as it had to be built on top of the hydraulic fill. By precluding sliding of the shells, it is considered that the capacity of the dam as a retaining structure would be maintained during the maximum probable earthquake. Since 1975, the reservoir level has been kept low, and will not be allowed to be raised until all the remedial measures have been finished. Densification results showed that the minimum required degree of densification had been achieved to avoid a dam failure towards downstream, should liquefaction occur below the dam body. The construction of the upstream berm is in progress, the berm will be an underwater fill composed of clean gravels. In the event of an occurrence of the maximum postulated earthquake, the dam could only be con-

sidered safe if the construction of the upstream berm were finished. (Mertz-PTT)
W91-04811

FILL DAM LEAKAGE BY NETWORK ASSESSMENT.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W91-04828

LESSONS LEARNED FROM COMPACTED CLAY LINER.
McClelland Engineers, Inc., Houston, TX.
For primary bibliographic entry see Field 5G.
W91-04839

8B. Hydraulics

LDA STUDY OF FLOW STRUCTURE IN SUBMERGED HYDRAULIC JUMP.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
D. Long, P. M. Steffler, and N. Rajaratnam.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 437-460, 1990. 22 fig, 1 tab, 15 ref, append.

Descriptors: *Flow models, *Flow pattern, *Hydraulic jump, Anemometers, Flow velocity, Froude number, Hydraulic properties, Shear stress, Three-dimensional model, Turbulent flow.

The flow structure of submerged hydraulic jumps was investigated using laser doppler anemometry (LDA). The LDA study was conducted to provide detailed measurements of the mean velocity, turbulence intensities and shear stresses. Submerged jumps were formed in a horizontal rectangular channel of constant width with the submergence factor, S, varying approximately from 0.20 to 1.70 and inlet Froude number approximately equal to 3.0, 5.5, and 8.0. In the fully developed region of a submerged jump, which occupies about 85% of the roller length, the flow demonstrates some degree of similarity. Submerged hydraulic jumps are three-dimensional in nature. The climbing effect of the mean velocity component near side walls is due to the vortex motion near the gate. The losses of unit discharge and unit kinematic pressure plus momentum flux at the center plane occur, along with their gains, near the side walls. After the jump, the flow recovers into a two-dimensional flow. It is recommended that if a two-dimensional prediction for a submerged jump is obtained, its results be interpreted with caution. (MacKeen-PTT)
W91-04305

B-JUMP IN SLOPING CHANNEL, II.
Hirosaki Univ. (Japan). Faculty of Agriculture.
N. Kawagoshi, and W. H. Hager.
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 461-480, 1990. 16 fig, 1 tab, 7 ref, append.

Descriptors: *Channel flow, *Flow pattern, *Hydraulic jump, *Hydraulic properties, Air entrainment, B-jump, Flow velocity, Three-dimensional model, Turbulent flow, Velocity distribution.

The flow pattern of B-jumps was experimentally investigated for a 30 degree upstream bottom slope. Expressions are given for the sequent depths ratio, the length of surface roller, and the length of jump. To widen the scope of investigations and to analyze the internal flow features of B-jumps some typical velocity distributions were measured. Compared to a hydraulic jump, the jet type flow is characterized by reduced air entrainment, smaller transverse velocity gradients and a much longer interface. Although there were distinct differences between jet and jump flows, some common main trends were observed. All velocity profiles contained a boundary layer of small height, above which lay the diffusion layer. Towards the surface, the return flow may become quite strong. The further analysis of flow involved the time-averaged three-dimensional flow pattern. The transverse distribution of bottom velocity was found to be inverse to the typical velocity distribution. The non-uniformity of flow was at times so strong that the maximum bottom velocity was larger than twice the average velocity. The reason for the particular bottom velocity distribution lies primarily in the roller flow. Once beyond the end of the roller the bottom velocity profile redeveloped quickly. B-jumps can be considered as intermediate cases as regards the decay of maximum velocity along the channel axis. It is concluded that results should be useful for design purposes. (MacKeen-PTT)
W91-04306

COMPREHENSIVE LIST OF PIPE COEFFICIENTS OF FRICTION FOR THE HAZEN-WILLIAMS AND MANNING FORMULAE DERIVED FROM THE DARCY-WEISBACH FORMULA AND COLEBROOK-WHITE TRANSITION LAW FOR ROUGHNESS VALUES (K).
Fort Hare Univ., Alice (South Africa). Dept. of Agricultural Engineering.
M. D. Radford.
Water SA WASADV, Vol. 16, No. 4, p 237-256, October 1990. 3 ref, 2 append.

Descriptors: *Head loss, *Hydraulic engineering, *Hydraulic friction, *Hydraulic roughness, *Pipe flow, Coefficient of friction, Darcy-Weisbach equation, Hazen-Williams equation, Hydraulic systems, Hydraulics, Mannings equation.

Head losses obtained with the Darcy-Weisbach, Hazen-Williams and Manning formulae for a specific type of pipe vary considerably when published coefficients are used. As the Darcy-Weisbach with the Colebrook-White transition law are considered the best formulae available for determining hydraulic head losses in pipes, coefficients of friction for Hazen-Williams and Manning have been calculated for roughness values which are recommended to be used in the Colebrook-White equation. Tables of coefficients are provided for roughness values (k) from 0.015 to 6 mm, nominal pipe diameters from 15 to 500 mm and velocities from 0.5 to 6 m/s. The Hazen-Williams formula is recommended for k values <0.15 mm and the Manning formula when k >0.15 mm. For $k=0.15$ mm, either formula may be used. An added advantage of the tables is that as more accurate roughness values become available for different types of pipes, the appropriate coefficient for either Hazen-Williams or Manning can be found. (MacKeen-PTT)
W91-04315

EXPERIMENTAL STUDY OF THE EFFECT OF BED GRAIN ROUGHNESS ON SEDIMENT SORTING BY ENTRAINMENT.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W91-04316

8C. Hydraulic Machinery

STRATEGY FOR THE MODERNIZATION OF CONTROL EQUIPMENT.
Voith (J. M.) G.m.b.H., Heidenheim (Germany, F.R.).
W. Veil.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 11, p 24-29, November 1990.

Descriptors: *Control systems, *Hydroelectric plants, *Management planning, *Rehabilitation, *Upgrading, Automation, Economic aspects, Governors, Oil supply, Safety.

Increased demands on both technology and economic efficiency make the question of new or renewed regulating devices at old hydroelectric power stations vital. Depending on the condition of the old regulating device, new characteristics required, or the degree of automation desired, there are many possibilities. Measurements to be taken in the plant as part of the assessment include checking the oil supply system, checking the control functions, and checking the safety equipment. Most old plants were not intended to be operated automatically or remotely. Today, automatic operation is desired for most hydropower stations. Thus, one of the factors to consider in determining whether to renew or replace equipment is the operational requirements demanded by today's environment. Modernization can be done along a gradient of increasing effort: maintenance of serviceability, replacement of hydromechanical governor and conversion of the hydraulic amplification, or renewal of the hydraulic governor and control equipment. A new oil supply system also may be required. (Rochester-PTT)
W91-04427

OPERATIONAL PROBLEMS AND DEVELOPMENT OF A NEW RUNNER FOR SILTY WATER.
Srinagar Hydro-Electric Projects, Dehra Dun (India).
C. S. Singh.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 11, p 29-34, 36-37, November 1990. 4 fig, 3 tab, 7 ref.

Descriptors: *Abrasion, *Cavitation, *Deterioration, *India, *Turbines, Alloys, Quartz, River Bhagirathi, Silt, Tiloth Hydro Power Station.

Tiloth hydro power station (3 x 30 MW) exploits the waters of the River Bhagirathi, a tributary of the River Ganges, in northern India. The three units were commissioned in the last quarter of 1984. Extensive damage to turbines was noted at about 2600 hr of operation; after repairs damage again occurred by 3000-5000 hr. Petrographic analysis indicated the presence of a highly abrasive silt (quartz of hardness of 7 on Mohr's scale as well as other hard particles) in the water. The presence of silt apparently was accelerating the loss of metal made spongy by cavitation. Other possible causes included possible rough finish on the turbine blades and the presence of sand, which enlarged the cavitation region. During operation of the turbines, the following observations were made: (1) air was being sucked in when the turbines were operated at full load; (2) while developing full load, the guide vane openings were around 70%; and (3) the noise level was highest at part load. After a full analysis, it was concluded that early turbine failure was caused by thinning of the turbine outlet edges as a result of abrasive silt and fatigue failure caused by vibrations and operation of the turbines under part load conditions. As a short-term measure, the turbines are being operated at below full load. Ultimately, several steps will be taken to correct the problems. These include redesign of the runners, improvement of the metallurgy of the steel, and the development of coatings or tiles. (Rochester-PTT)
W91-04428

UPGRADE OF PROCUREMENT SPECIFICATIONS: MATERIALS, MANUFACTURE AND SETTING.
Harza Engineering Co., Chicago, IL.
R. W. Fazalare.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 11, p 38-42, 45, November 1990. 5 fig, 6 ref.

Descriptors: *Hydraulic equipment, *Hydroelectric plants, *Rehabilitation, *Specifications, *Upgrading, Economic analysis, Hydraulic machinery, Management planning, Procurement, Testing procedures.

Requirements for and benefits of upgrading procurement specifications for hydro power equipment is discussed. Specifications to meet today's requirements are discussed in relation to: turbine setting and speed selection; materials and manufacture (turbine runner materials, runner construction, spiral case and stayring, guidevanes, guidevane bushings, discharge ring throat liner, turbine-embedded piping, Kaplan piping, and stayvane cracking); spiral case embedding and site machining; shaft alignment and runout tolerance; surface roughness finish; non-destructive testing of components and welds; turbine draft tube liners (typical design criteria, draft tube fins); unit guide bearings;

main shaft seal; aeration, cooling water, and pressure tap connections; and miscellaneous features. By upgrading procurement specifications, the purchaser can convey to the bidders the message that machines must be of refined design, efficient and of the highest practicable quality, built for endurance, low maintenance, and long useful life, and that the purchaser is willing to pay the price for such machines. As a power producer, the purchaser cannot afford to purchase machines that cause lost generation because of unscheduled downtime. (See also W91-02158) (Rochester-PTT)
W91-04429

PUMPING STATION REHABILITATION WITH SUBMERSIBLE PUMPS SAVES O&M COSTS.
BCM Engineers, Inc., Plymouth Meeting, PA.
For primary bibliographic entry see Field 5D.
W91-04607

MECHANICAL AND ELECTRICAL EQUIPMENT FOR COLOMBIA'S GUAVIO PROJECT.
Ingetec S.A., Bogota (Colombia).
C. S. Ospina.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 12, p 9-17, December 1990. 8 fig, 1 tab.

Descriptors: *Colombia, *Electrical equipment, *Hydroelectric plants, *Powerplants, Dams, Electric power, Electrical transmission, Hydroelectric power, Pelton Turbines, Powerplant design, Turbines.

Guavio hydroelectric project is a high head development with a deep underground powerhouse, located in Colombia, approximately 80 km northeast of Bogata. The project will have a final capacity of 1600 megawatts, with 1000 megawatt installed in the initial stage. The rockfill dam is 245 m high the water conveyance system consists of a 13.3 km-long upper tunnel, and 515 m vertical pressure shaft and two lower tunnels and distribution manifolds. Two 14 m-high, 10 m-wide gates are provided with counterweights, placed at the end of the gate arm extensions, to ensure that gate opening can take place if no power is available. Closure of the power tunnel is by butterfly valves placed 300 m downstream of the tunnel intake. Each turbine may be closed off from the distribution manifold by a spherical valve, 1.4 m in diameter, which is provided with double seals and operated by penstock water acting an a torus shaped hydraulic severomotor. Each of the five-jet Pelton turbines is rated at 224 megawatt under a net head of 1093 m. A 10% overstroke allows the machine to develop a maximum of 261 megawatt with a net head of 1140 m, but output will normally be limited to 239 megawatt to avoid unnecessary wear. Careful consideration of the turbine outputs, together with the reactive power requirements of the electrical transmission system, led to the selection of a machine with a rating of 270 MVA at 0.85 power factor, with a maximum winding temperature rise of 80 C. The excitation system is of the static, potential-source type with the excitation transformer directly connected to the generator busbars. The 230 kilovolt switchgear is provided with optical flashover detection in each gas compartment, nickel bursting plates for pressure relief and gas-density monitoring instruments. The 230 kilovolt SF6 gas-insulated ground level substation has a similar configuration to the underground switchgear. Based on an initial idea of providing emergency power from small Pelton turbine generators instead of the usual diesel generators, the concept was developed of having two larger units, each with sufficient capacity to provide all the power requirements of the plant auxiliary services, including the auxiliary services of the eight main generating units. Control buildings, powerhouse, and spillway control house are all linked by fiber optic cable. (Mertz-PTT)
W91-04807

DESIGN FEATURES OF VENEZUELA'S MACAGUA II SCHEME.
EDELCA, Caracas (Venezuela).
Z. Prusza V., and H. Roo Gomez.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 12, p 19-22, December 1990. 3 fig.

Descriptors: *Hydroelectric plants, *Powerplants, *Venezuela, Bridges, Dams, Environmental effects, Environmental protection, Highways, Hydroelectric power, Urban planning, Waterfalls.

The design of Venezuela's 2540 megawatt Macagua scheme, on the Caroni River, presented several engineering challenges: the project is located very close to a rapidly expanding urban area, and special efforts were made to bring some specific environmental benefits to the area (in addition to the power produced), including improvements to the local infrastructure in the form of roads and bridges. The first stage of Macagua was completed in 1961 with 370 megawatt of installed power, and provision for future expansions. The Macagua II project, currently under construction, comprises one impounding dam, a spillway and two hydroelectric powerplants capable of generating 2540 megawatt. As part of the preliminary works, a distribution causeway was built in 1985, to channel water to the La Llovizna Falls, one of the country's most scenic attractions. Other tasks consisted of the final excavation for the main structures and the partial construction of the rockfill dams. Once the supply streams for the Cachamay and La Llovizna Falls have been diverted, they will be replaced by the water discharged exclusively for this purpose from powerhouse no. 3. The San Felix bridge and a bridge over tailrace channel no. 1 have been built, and these facilitate access for visitors to La Llovizna Park as well as construction and operation personnel to the project site. Both of these direct access roads to Macagua II will be linked to the national highway to be built downstream of powerhouses and the dams. (Mertz-PTT)
W91-04808

PLANNING HYDROELECTRIC DEVELOPMENTS IN ARGENTINA.
Acquasolum S.A., Buenos Aires (Argentina).
For primary bibliographic entry see Field 8A.
W91-04809

8D. Soil Mechanics

ASSESSMENT OF ATM AND SATELLITE DATA FOR ESTIMATING THE GROUNDWATER CONTRIBUTION TO SLOPE STABILITY.
University Coll., Cardiff (Wales). Dept. of Civil and Structural Engineering.
For primary bibliographic entry see Field 7B.
W91-03958

CENTRIFUGAL MODELING OF DRAINS FOR SLOPE STABILIZATION.
McClelland Engineers, Inc., Ventura, CA.
G. S. Resnick, and D. Znidarcic.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 11, p 1607-1624, 1990. 9 fig, 28 ref.

Descriptors: *Drains, *Model studies, *Slope stabilization, *Soil stability, Design charts, Design criteria, Groundwater seepage, Horizontal drains, Safety, Subsurface drains.

Horizontal drains are commonly used to stabilize slopes or embankments in which groundwater seepage is the main cause of instability. When using horizontal drains to remedy an unstable slope, the length, spacing, and position of the drains must be chosen. These drain placement parameters are usually chosen on the basis of engineering judgement; sometimes they are obtained from published design charts. A methodology is presented that can be used to develop or experimentally verify such charts. Model slopes were tested in a geotechnical centrifuge to evaluate the influence of horizontal drains on the distribution of piezometric levels within slopes. The observed results, from those experiments in which drains were installed in the model slopes, were compared to reference conditions obtained from experiments without drains. Good agreement between the observed phenomena and the analysis was found. The methodology can be employed to develop design charts in which the drain placement parameters are related to the increase in the factor of safety. The development of such charts would require an extensive testing program in which slope geometry and drain placement parameters would be changed over a range that brackets conditions likely to be encountered in practical applications. The limited capacity of the centrifuge used in the research precluded a complete verification of the published design charts, but the results demonstrated the usefulness of the centrifugal modeling technique in studying the process of slope stabilization. (Author's abstract)
W91-04838

8E. Rock Mechanics and Geology

ABSORPTION OF WATER INTO POROUS BLOCKS OF VARIOUS SHAPES AND SIZES.
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5E.
W91-04133

DIFFUSION IN THE MATRIX OF GRANITIC ROCK: FIELD TEST IN THE STRIP A MINE.
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W91-04137

ESTIMATION OF EMBANKMENT DAM SETTLEMENT CAUSED BY EARTHQUAKE.
R. B. Jansen.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 12, p 35-40, December 1990. 1 fig, 1 tab, 13 ref.

Descriptors: *Dam stability, *Earthquake engineering, *Earthquakes, *Embankments, *Model studies, *Seismic properties, Dam embankments, Dam failure, Dam foundations, Dams, Earthquake effects, Liquefaction, Mathematical analysis, Mathematical models.

Important progress has been achieved in defining methods for estimating the response of embankments to seismic loading (earthquakes). Some of the elaborate analytical methods now available tend to give an impression that the science is more advanced than it really is. Simulation of dam performance by a mathematical model involves uncertainties related to the seismic setting as well as the dam itself. Nonuniform and changing conditions must be kept in mind in conducting any numerical analysis, whether it be simplified or complex. Whatever the method used, several analyses may be advisable, using parametric variations to bracket the possible embankment and foundation behavior. The critical measure of an embankment's capability is the relationship of its freeboard to potential settlement, as well as its resistance to cracking and internal erosion. In cases where the dam and its foundation would not be susceptible to liquefaction, settlement can be estimated by simplified methods based on a computed yield acceleration. If liquefaction is a possibility, dynamic analysis is essential. The yield acceleration can be calculated by the common sliding block or slices methods, or by equations based on moments about the center of rotation of the sliding mass. The expanding volume of data from numerous analyses under wide ranges of conditions has enabled envelopes to be drawn of indicated dam performance. By coupling these analytical results with the few observations of real response in major earthquakes, a basis has been provided for evaluating the capability of embankments and, by simplified examination, screening those which are clearly adequate from others that may need further study. Both linear and nonlinear methods must be accompanied by the caveat that their accuracy depends heavily on the quality of the input data. (Mertz-PTT)
W91-04810

ENSURING THE DYNAMIC STABILITY OF SESQUILE DAM IN COLUMBIA.
Ingetec S.A., Bogota (Colombia).
For primary bibliographic entry see Field 8A.
W91-04811

8G. Materials

REPAIRS TO THE MARTIN GONZALO DAM.
Strabag Bau S.A., Madrid (Spain).
For primary bibliographic entry see Field 8A.
W91-04426

SEALING EARTHEN HYDRAULIC STRUCTURES WITH ENHANCED GLEIZATION AND SODIUM CARBONATE: I. LABORATORY STUDY OF THE EFFECT OF A FREEZE-THAW CYCLE AND A DRYING INTERVAL.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
B. G. McConkey, C. D. Reimer, and W. Nicholaichuk.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 163-170, July 1990. 5 fig, 3 tab, 44 ref.

Descriptors: *Drying, *Earth dams, *Earthworks, *Freeze-thaw tests, *Hydraulic conductivity, *Hydraulic structures, *Irrigation engineering, *Sealants, *Seepage control, Flooding, Saturated soils, Sodium compounds, Soil organic matter, Soil physical properties, Soil tests, Straw.

Excessive seepage from many earthen reservoirs and irrigation canals is a serious problem. The addition of organic materials to the soil has been found to reduce the seepage from earthen hydraulic structures. A laboratory study was conducted to investigate the effect of a freeze-thaw cycle and of a drying interval on the saturated hydraulic conductivity (k) of soils treated with soil-incorporated sodium carbonate (Na2CO3) and enhanced gleization (i.e. a buried straw layer). Gleization caused k to decline with time, with the decline being more rapid with a buried straw layer after a freeze-thaw cycle or a drying interval rebounded to the initial values which had existed before gleization. The sealing effect of Na2CO3 was largely lost after freezing and thawing following prolonged flooding but a drying interval did not increase k of the soil with 20% clay which was treated with Na2CO3 and a buried straw layer. Sealing earthen hydraulic structures with enhanced gleization and Na2CO3 would only be practical where the initial k of the untreated soil in the structure bed was approximately 0.000001 m/s or less and where seepage could be tolerated during initial flooding and after a freeze-thaw cycle or a drying interval. (See also W91-04544) (Author's abstract)
W91-04543

SEALING EARTHEN HYDRAULIC STRUCTURES WITH ENHANCED GLEIZATION AND SODIUM CARBONATE: II. APPLICATION FOR LINING AN IRRIGATION CANAL.
Agriculture Canada, Swift Current (Saskatchewan). Research Station.
B. G. McConkey, C. D. Reimer, W. Nicholaichuk, and Y. W. Jame.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 171-176, July 1990. 1 fig, 8 tab, 20 ref.

Descriptors: *Canal linings, *Canal seepage, *Hydraulic structures, *Irrigation canals, *Irrigation engineering, *Sealants, *Seepage control, Canal design, Flooding, Saturated soils, Sodium compounds, Soil organic matter, Soil physical properties, Soil tests, Straw.

Excessive seepage from earthen irrigation canals is an important problem. The enhanced gleization method of seepage control consists of adding organic materials to the soil of earthen hydraulic structures. A small intermittently-flooded irrigation canal was treated with the enhanced gleization method (i.e. a buried straw layer) and soil-incorporated sodium carbonate (Na2CO3) to reduce seepage losses. Na2CO3 provided only short-term seepage control. For flooding periods of 12 days or less, a buried straw layer reduced seepage from the irrigation canal by 30% but seepage rates were still unacceptably high. Seepage rates increased following the over-winter period and after a drying interval of more than eight days. Enhanced gleization, even when combined with soil-incorporated Na2CO3, did not provide satisfactory long-term seepage control for intermittently-flooded irrigation canals. (See also W91-04543) (Author's abstract)
W91-04544

RESISTANCE TO MICROBIOLOGICAL DETERIORATION OF GEOTEXTILES USED AROUND AGRICULTURAL DRAINS: A REVIEW.
Alberta Univ., Edmonton. Dept. of Clothing and Textiles.
E. A. Richards, S. Y. Martin-Scott, J. D. Scott, and M. E. Hodges.
Canadian Agricultural Engineering CAEOAI, Vol. 32, No. 2, p 177-181, July 1990. 27 ref.

Descriptors: *Agricultural engineering, *Durability, *Fabrics, *Geotextiles, *Materials engineering, *Microbial degradation, *Reviews, *Subsurface drains, *Textiles, Biodegradation, Oxidation, Photolysis, Plastics, Polymers, Soil chemistry, Soil properties.

The long-term durability of geotextiles is an issue of increasing concern. The durability of geotextiles to microbiological degradation is reviewed for soil burial applications such as envelope wraps around subsurface horizontal pipe drains. Few researchers have examined the degradation of geotextiles. The degradation of plastics and films in soil is disputed; the research does not indicate conclusively whether the cause of the degradation is the soil chemistry, microorganisms, or normal aging processes. The factors which affect microbiological degradation of synthetic polymers in geotextiles are the polymer chain length, branching of the polymer chain, crystallinity and moisture absorption of the fiber, type of chemical bond and the surface area of the fabric. Although microbiological degradation is not considered a serious concern for these materials, photooxidation prior to soil burial increases biodeterioration. The chemistry of typical soils is not a significant factor in biodeterioration of geotextiles. Polypropylene and polyester (polyethylene terephthalate) fabrics are recommended for subsurface drainage applications. These fibers should be stabilized with ultraviolet light inhibitors to prevent photooxidation. (Author's abstract)
W91-04545

DURHAM BENEFITS FROM COLLECTION SYSTEM INSTRUMENTATION.
For primary bibliographic entry see Field 5D.
W91-04598

LATERAL INSTALLATION AND MAINTENANCE CONSIDERATIONS.
Gannett, Fleming, Corddry and Carpenter, Inc., Harrjsburg, PA.
For primary bibliographic entry see Field 5D.
W91-04608

FILL DAM LEAKAGE BY NETWORK ASSESSMENT.
Gifu Univ. (Japan). Dept. of Civil Engineering.
T. Sato.
Advances in Water Resources AWREDI, Vol. 13, No. 2, p 85-89, 1990. 5 fig, 5 tab, 3 ref.

Descriptors: *Dam leakage, *Earth dams, *Groundwater movement, *Japan, *Model studies, Borings, Data analysis, Finite element method, Leakage, Monte Carlo method, Reservoirs.

A stochastic method for making a prediction of groundwater leakage through an earthfill dam and subsoils was developed using a dam in Hokkaido, Japan as a case study. Due to widely scattered values of boring and in-situ test results, conventional approaches were not suitable. In developing the model the region was divided into two subregions, the upstream and downstream zones bounded by the dam. The main point of the method was to construct a network for a geological structure within a flow region which consists of node points and branches. The node point gave an imaginary space coordinate of a soil deposit. The branch played the role of a groundwater conduit in the model. All soil layers in the boring logs were designated as the node points, but this nomination should be limited to the layers relating to the groundwater flow from the reservoir. The model has substantial parameters for prescribing the groundwater flow, such as permeability, thickness and length of soil layer. These values were obtained from boring and in-situ test results, which are usually widely scattered even in the same soil layer. A Monte Carlo simulation was used to take the values into account. The network analysis takes into account the uncertainties of not only the geological structure but the value of permeability. The method is practical because it takes into account the uncertainties and scatters of the investigation results; however, the model is only available for the steady-state condition of groundwater flow. (White-Reimer-PTT)
W91-04828

8I. Fisheries Engineering

STATUS OF THE FOURHORN SCULPIN, MYOXOCEPHALUS QUADRICORNIS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04088

STATUS OF THE SPOONHEAD SCULPIN, COTTUS RICEI, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04089

STATUS OF THE BROOK SILVERSIDE, LABIDESTHES SICCULUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04091

STATUS OF THE BANDED KILLIFISH, FUNDULUS DIAPHANUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04092

STATUS OF THE LEAST DARTER, ETHEOSTOMA MICROPERCA, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04093

STATUS OF THE RIVER DARTER, PERCINA SHUMARDI, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04094

STATUS OF THE REDBREAST SUNFISH, LEPOMIS AURITUS, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04095

STATUS OF THE ORANGESPOTTED SUNFISH, LEPOMIS HUMILIS, IN CANADA.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 5C.
W91-04096

STATUS OF THE BIGMOUTH BUFFALO, ICTIOBUS CYPRINELLUS, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04097

STATUS OF THE BLACK BUFFALO, ICTIOBUS NIGER, IN CANADA.
For primary bibliographic entry see Field 5C.
W91-04098

STATUS OF THE GOLDEN REDHORSE, MOXOSTOMA ERYTHRURUM, IN CANADA.
For primary bibliographic entry see Field 2H.
W91-04099

CYTOLOGICAL STUDY OF VACUOLATED CELLS AND OTHER ABERRANT HEPATOCYTES IN WINTER FLOUNDER FROM BOSTON HARBOR.
Rhode Island Univ., Kingston. Coll. of Resource Development.
For primary bibliographic entry see Field 5C.
W91-04363

SUBCELLULAR LOCALIZATION OF ACID-RAIN TRANSPORTED ALUMINUM IN GILLS AND KIDNEYS OF TROUT FROM STREAMS OF THE VOSGES: PRELIMINARY RESULTS, (LOCALISATION SUBCELLULAIRE DE L'ALUMINIUM VEHICULE PAR LES PLUIES ACIDES DANS LES REINS ET BRANCHIES DE TRUITE DES VOSGES. DONNEES PRELIMINAIRES).
Clermont-Ferrand-1 Univ. (France). Faculte de Medecine et de Pharmacie.
For primary bibliographic entry see Field 5B.
W91-04364

FOOD CHAIN STRUCTURE IN ONTARIO LAKES DETERMINES PCB LEVELS IN LAKE TROUT (SALVELINUS NAMAYCUSH) AND OTHER PELAGIC FISH.
McGill Univ., Montreal (Quebec). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W91-04445

EFFECTS OF ENVIRONMENTAL FACTORS ON JUMPING BEHAVIOUR OF THE JUVENILE AYU PLECOGLOSSUS ALTIVELIS WITH SPECIAL REFERENCE TO THEIR UPSTREAM MIGRATION.
Tokyo Univ. (Japan). Ocean Research Inst.
K. Uchida, K. Tsukamoto, and T. Kajihara.
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 9, p 1393-1399, September 1990. 7 fig, 2 tab, 22 ref.

Descriptors: *Fish behavior, *Fish migration, *Light intensity, *Photoperiodism, *Waterfalls, Fish populations, Juvenile growth stage.

The jumping behavior against a waterfall of ayu (Plecoglossus altivelis) is known to be closely related to the tendency to migrate upstream in a river. In order to determine the mechanism for triggering upstream migration in the ayu, the effects of environmental factors on jumping activity were observed. Jumping behavior was frequent in the time period corresponding to daytime, even under constant light conditions, LL and DD photoperiods as well as 16L8D. The jumping activity was facilitated by changes in light intensity, raising of the water temperature, shallow water depth, and deprivation of food. These changes in environmental factors appear to have the potential to act as a trigger for the migratory behavior. (See also W91-04527) (Author's abstract)
W91-04526

EFFECT OF PARENTAL ORIGIN ON JUMPING AND SPACING BEHAVIOURS OF JUVENILE AYU PLECOGLOSSUS ALTIVELIS WITH SPECIAL REFERENCE TO THEIR UPSTREAM MIGRATION.
Tokyo Univ. (Japan). Ocean Research Inst.
K. Uchida, K. Tsukamoto, R. Ishida, S. Ishii, and T. Kajihara.
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 9, p 1401-1405, September 1990. 2 fig, 2 tab, 14 ref.

Descriptors: *Fish behavior, *Fish migration, *Fish stocking, *Genetics, *Jumping, *Juvenile growth stage, Aggregation.

The spacing pattern and jumping activity were compared for three different stocks of juvenile ayu (Plecoglossus altivelis), reared under identical hatchery conditions for about three months after fertilization. These stocks were the offspring of landlocked fish from Lake Biwa (LAKE), amphidromous fish from the Kiso River (RIVER) and the fourteenth generation hatchery strain kept at Gunma prefecture (HR-G). LAKE dispersed widely in an experimental tank (95 cm in diameter) during the daytime, while HR-G formed a tight aggregation and/or schooling in a mean diameter of 48 cm. Jumping activity was highest in LAKE (4.0 times per individual), followed by RIVER (3.3) and HR-G (3.0). These results suggest that parental origin, or genetic factors, control the spacing and jumping behaviors of the ayu, and, thus, the upstream migration of this species. (See also W91-04526) (Author's abstract)
W91-04527

FLOW DYNAMICS AND FISH RECOVERY EXPERIMENTS: WATER INTAKE SYSTEMS.
Great Salt Bay Experimental Station, Damariscotta, ME.
R. I. Fletcher.
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 3, p 393-415, May 1990. 13 fig, 6 tab, 11 ref.

Descriptors: *Fish barriers, *Fish passages, *Fishkill, *Intake gates, *Trash racks, Atlantic tomcod, Fish impingement, Nuclear powerplants, Ristroph screens, Striped bass, White perch.

Large water-use facilities are often equipped with vertically travelling debris barriers known as Ristroph screens. The imposed fish mortalities associated with these machines are commonly attributed to the consequences of impingements, but laboratory and field experiments indicate that in those circumstances where the screens travel continuously and where water speeds are moderate, the major underwater injuries are attributable instead to buffeting of captured fish within the fish troughs proper. Captured fish often escaped an ascending trough just before its leading edge broke the water surface, and their repeated encounters with the fish recovery apparatus increased the risk of mortality. From flow analyses of reshaped trough and screen profiles, a flow spoiler was devised that eliminates the trough vortex and buffeting of captive fish. The escape of fish at the water surface was eliminated by means of an auxiliary screen affixed to the leading edge of each fish trough. Field experiments revealed other sources of mortality, chief of which was the entanglement of fish in captured debris. As a countermeasure, the order of removing fish and debris was reversed. A reconfigured machine, including the redesigned fish-catching apparatus, was installed and tested at a nuclear generating station on the Hudson River estuary. In tests similar to those on the unimproved machine, injuries and deaths were reduced from 53 to 9% for striped bass Morone saxatilis, from 64 to 14% for white perch Morone americana, from 80 to 17% for Atlantic tomcod Microgadus tomcod, and from 47 to 7% for pumpkinseed Lepomis gibbosus. Striped bass losses to the debris removal system were reduced from 23% of recoveries to zero, white perch losses from 33% to 1.3%, and Atlantic tomcod losses from 20% to 0.3%. Release-recovery experiments with juvenile striped bass and white perch revealed probabilities of capture characteristic of weak and strong swimmers. (Author's abstract)
W91-04588

ANNUAL PRODUCTION AND PRODUCTION: BIOMASS RATIOS FOR THREE SPECIES OF STREAM TROUT IN LAKE SUPERIOR TRIBUTARIES.
Minnesota Univ., St. Paul. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 2H.
W91-04589

REGRESSION MODEL FOR PREDICTING CATCH FROM WATER LEVEL OF HIGH DAM LAKE IN EGYPT.
Tokyo Univ. (Japan). Lab. of Fishing Science and Technology.
Y. Yamaguchi, N. Hirayama, S. Yamada, A. Koike, and Z. Morad.
Journal of the Tokyo University of Fisheries (Tokyo Suisan Daigaku Kenkyu Hokoku), Vol. 76, No. 1/2, p 73-81, November 30, 1989. 6 fig, 6 tab, 5 ref. English summary.

Descriptors: *Fish populations, *Lake fisheries, *Lake shores, *Mathematical models, *Model studies, *Regression analysis, *Tilapia, *Water level, Egypt, Fish stocking, Fisheries, Reservoirs, Spawning.

A multiple regression model was used to predict the catch of Tilapia nilotica and Tilapia galilaea, which are the most important species for fishing in High Dam Lake in Egypt. During spawning season, Tilapia tends to establish and protect a certain territorial area. For this reason, reproduction of Tilapia is influenced by shoreline length. Based on the relation between water level and shoreline length, the length of the shoreline in May was calculated for each year. May is the spawning season and is the peak of the Tilapia fishing season. A multiple regression analysis of the natural logarithm of the index of stock abundance on the shoreline length at 0, 1, 2, 3 years before was obtained. Since multicolinearity existed among the four explanatory variables, two explanatory variables were selected by the Ridge regression method. Examination of residuals from the reduced regression model indicated that this model is reasonable and is applicable for predicting catches as far as the present conditions of the fishery remain unchanged. (Author's abstract)
W91-04718

DISTRIBUTION AND ABUNDANCE OF PACHYMELANIA AURITA IN LAGOS LAGOON, NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W91-04741

FISH OF THE AMAZONIAN IGAPO: STABILITY AND CONSERVATION IN A HIGH DIVERSITY-LOW BIOMASS SYSTEM.
Central Electricity Generating Board, Fawley (England). Marine Biological Unit.
For primary bibliographic entry see Field 2H.
W91-04784

CONSERVATION STATUS OF THE NORTH AMERICAN FISH FAUNA IN FRESH WATER.
Bureau of Land Management, Washington, DC. Wildlife and Fisheries Div.
For primary bibliographic entry see Field 6G.
W91-04785

CONSERVATION AND STATUS OF THREATENED FISHES IN SOUTHERN AFRICA.
J.L.B. Smith Inst. of Ichthyology, Grahamstown (South Africa).
For primary bibliographic entry see Field 6G.
W91-04786

RARE BRITISH MARINE FISHES--IDENTIFICATION AND CONSERVATION.
Marine Biological Association of the United Kingdom, Plymouth (England).
S. E. Swaby, and G. W. Potts.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 133-143, 1990. 3 tab, 20 ref, append. Nature Conservancy Council Contract No. HF3.03.417.

Descriptors: *Bioindicators, *Computers, *Data collections, *Databases, *Endangered species, *Fish conservation, *Marine environment, *Species diversity, *United Kingdom, Abundance, Aquatic habitats, Estuaries, Geographic distribution, Maps, Water pollution effects.

Methods of recording and categorizing rare British marine fishes and their habitats include techniques

based on categories of abundance (abundant, common, average, uncommon, scarce, and indeterminate), categories of distribution (extensive, widespread, restricted, localized, single population, indeterminate, occasional vagrant), or categories of threatened species (endangered, vulnerable, rare, indeterminate, insufficiently known). Information is stored on a database designed for maximum flexibility, cross-referencing, multiple word search and key word search facilities. The information for the database is collected using species and habitat recording cards. These cards have been modified from the Marine Nature Conservation Review cards, expanded and developed to hold information on all aspects of fishes and their biology. This information is supplemented by references, maps and records of occurrences for each species. The database provides a unified system capable of collating all known occurrences of rare British marine fishes. Using categories of abundance and distribution allows a preliminary assessment of the status of British fishes to be made and identifies those species that may be considered rare or threatened. Of eight identified threatened species, five occur in estuaries, two are shallow coastal and one is found on offshore benthic habitats. The reduction of pollution in the River Thames has shown how quickly fish will recolonize previously toxic and polluted waters, and similar actions need to be considered for most estuaries. (Brunone-PTT)
W91-04787

LAKE ENRICHMENT AND THE STATUS OF WINDERMERE CHARR, SALVELINUS ALPINUS (L).
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 5C.
W91-04788

THREATENED NATIVE FRESHWATER FISHES IN AUSTRALIA--SOME CASE HISTORIES.
New South Wales Dept. of Agriculture, Narrandera (Australia). Inland Fisheries Station.
B. A. Ingram, C. G. Barlow, J. J. Burchmore, G. J. Gooley, and S. J. Rowland.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 175-182, 1990. 20 ref.

Descriptors: *Aquatic habitats, *Australia, *Conservation, *Endangered species, *Fish conservation, *Fish populations, Creeks, Endemism, Geographic distribution, Headwaters, Lakes, Minnow, Water resources management.

Case histories of some of Australia's most threatened native freshwater fishes are presented for six endangered species (Galaxias fontanus, G. johnstoni, G. pedderensis (Galaxiidae), Melanotaenia eachamensis (Melanotaeniidae), Maccullochella sp. nov. and M. macquariensis (Percichthyidae); one vulnerable species (G. tanycephalus); two potentially threatened species, G. parvus and Prototroctes maraena (Prototroctidae); one indeterminate species, Maccullochella sp; one restricted species, Macquaria australasica. G. fontanus is found only in a few small streams in eastern Tasmania. G. johnstoni was once widespread throughout the Clarence River system of central Tasmania, but is now confined to two natural lakes and one small creek system within the headwaters of the river. G. pedderensis and G. parvus are endemic to the Lake Pedder region in south-western Tasmania. G. tanycephalus occurs in only two partially modified natural lakes, Arthurs Lake and Woods Lake in central Tasmania. Prototroctes maraena is found in small, isolated populations in Tasmania and throughout the south-eastern coastal drainage area of Australia. This fish is protected in both Tasmania and New South Wales. Melanotaenia eachamensis is difficult to evaluate, because the population decline was not monitored quantitatively over a period of time. Conservation management strategies that have been or are being applied to most of these species include protection of the fish and their habitats, establishment of refuge populations, and artificial propagation and re-establishment programs. (Brunone-PTT)
W91-04789

IMPACT OF DAMMING, DROUGHT AND OVER-EXPLOITATION ON THE CONSERVATION OF MARKETABLE FISH STOCKS OF THE RIVER BENUE, NIGERIA.
Portsmouth Polytechnic (England). Centre for Marine Resources Economics.
For primary bibliographic entry see Field 6G.
W91-04790

THREATENED FISHES OF BAROMBI MBO: A CRATER LAKE IN CAMEROON.
Horniman Museum, London (England).
G. M. Reid.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 209-211, 1990. 7 ref.

Descriptors: *Cameroon, *Cichlid, *Crater Lake, *Endangered species, *Fish conservation, *Species diversity, Agricultural chemicals, Air pollution effects, Aquatic habitats, Dam construction, Deforestation, Economic aspects, Evolution.

Barombi Mbo is a small crater lake in the rainforest belt of South West Cameroon. The lake contains 17 species of fish of which 70% are endemic, including 11 species of tilapine cichlid. The cichlids represent the only properly known West African example of a species flock, corresponding with the famous adaptive radiations in the East African Great Lakes. Major threats to Barombi Mbo can be conveniently grouped as internal and external. Internal factors include overfishing, damming of the Kake River outflow, deforestation, and increasing use of agrochemicals. External factors include alien species, aerial pollution, socioeconomic pressures, and visitor pressure. (Brunone-PTT)
W91-04791

RARE FISHES OF HIMALAYAN WATERS OF NEPAL.
Tribhuvan Univ., Kathmandu (Nepal). Dept. of Zoology.
T. K. Shrestha.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 213-216, 1990. 1 tab, 5 ref.

Descriptors: *Endangered species, *Fish behavior, *Fish conservation, *Fish management, *Fish populations, *Himalayas, *Nepal, Carp, Catfish, Dam construction, Erosion, Fish ladders, Headwaters, Hydroelectric power, Lakes, Loaches, Population dynamics, Rivers, Seasonal variation, Species diversity, Tailwater, Water channels, Water level, Water quality.

The fishes of Himalayan waters are biologically diverse. More than 130 species occur in the rivers and mountain lakes of the Nepalese highlands. In some rivers, dams and barrages have been constructed for hydroelectric power stations and navigational purposes. The dams do not have fish ladders and they obstruct and prevent upstream and downstream movements of fish. The shallow tailwater regions below dams where fish congregate are exploited by fisherman, poachers, and predatory animals, killing rare fishes. The scientific management of the Nepalese mountain streams has just begun. The local human population has increased dramatically. Sewage, detergents and herbicides entering the rivers are causing a critical deterioration of water quality. Spawning beds are being removed to provide sand and gravel for the building industry. Changes in land use and deforestation cause soil erosion and the rivers are loaded with silt in the rainy season. In order to conserve the rare and threatened species in Nepal, suitable water levels must be maintained in the tailwater regions of dams during the breeding season for stone carps, loaches, and catfishes. The provision of special spawning channels would help to maintain populations of masheer, snow trout, stone carp and torrent catfish. Consideration should also be given to the creation of one or more artificial river parks, containing channels and impoundments suitable for breeding rare fishes. (Brunone-PTT)
W91-04792

VALUES OF LOWLAND RIVERS FOR THE CONSERVATION OF RARE FISH IN FLANDERS.
Antwerp Univ., Wilrijk (Belgium). Dept. of Biology.
L. Bervoets, J. Coeck, and R. F. Verheyen.
Journal of Fish Biology JFIBA9, Vol. 37, No. Supp, p 223-224, 1990. 2 tab, 2 ref.

Descriptors: *Belgium, *Endangered species, *Fish conservation, *Fish populations, *Flanders, *Species diversity, *Stream biota, Geographic distribution, Grayling, Loaches, Open channels, Path of pollutants, Population density, Smelt, Sturgeon, Trout, Water pollution effects, Water resources management.

Flanders, Belgium has 39 species of freshwater fish, of which only 10 native species are not endangered. Seven species seem to have disappeared from the Flemish rivers: sturgeon, allis shad, twaite shad, houting, grayling, and smelt. Six of the most endangered species (sea trout, bitterling, spined loach, weather loach, stone loach, and bullhead) are protected by law. In addition, another ten species are directly endangered. Most of the Flemish rivers are heavily polluted but the basin of the River Nete, near Antwerp, has the highest density of water purification plants in Flanders and contains numerous lowland streams or good or very good water quality. In the Nete, a good correlation ($r = -0.88$) exists between the numbers of rare fish species and water quality based on biological oxygen demand and the concentrations of oxygen and ammonia-nitrogen. The River Nete contains 27 species of fish. Of these fishes, seven are directly endangered elsewhere in Flanders. The unique lowland river-network of the Nete is extremely important for conserving fishes which have very restricted distributions in Flanders. The spined loach has disappeared from the Flemish river except for the upstream section of the Nete, although this species seems to be less sensitive to canalization than are dace, ide, bullhead and brook lamprey. An undisturbed river channel is essential for the survival of the species. Their protection also requires the prevention of pollution and an increase in habitat diversity by restoration of streams. A possible solution is the establishment of fish reserves in the upper region of the Nete catchment. (Brunone-PTT)
W91-04793

THREATS TO THE SURVIVAL OF ANADROMOUS FISHES IN THE RIVER TAGUS, PORTUGAL.
Departamento de Zoologia e Antropologia, Faculdade de Ciencias de Lisboa, Campo Grande, Bloco C2, 3 Piso, 1700 Lisbon, Portugal.
For primary bibliographic entry see Field 5C.
W91-04794

RARE AND ENDANGERED FISHES FROM YUGOSLAVIAN ADRIATIC RIVERS.
Fisheries Research Inst., Ljubljana (Yugoslavia).
For primary bibliographic entry see Field 6G.
W91-04795

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

EDUCATION OF HYDROLOGISTS.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
J. E. Nash, P. S. Eagleson, J. R. Philip, and W. H. Van der Molen.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 6, p 597-607, December 1990. 3 ref.

Descriptors: *Education, *Hydrology, *Professional personnel, *Training, Engineering, Future planning, Geohydrology, Professional societies, Research priorities, United Nations.

Because of the failure of hydrologists to found their technology on a sound scientific basis, the science has developed slowly. This vicious circle can be broken only by a thorough review of the

science and technology of hydrology and a reassessment of the manner of education of hydrological scientists and technologists. The major inadequacies of present-day hydrology are: methodological deficiencies; the slowness of scientific advancement in understanding hydrology through research; and the slow diffusion of knowledge from research to practice. A panel from the International Association of Hydrological Sciences and UNESCO was formed to evaluate hydrological education. The panel recommended that undergraduate education should give explicit attention to hydrology and an integral component of geoscience with sufficient depth and coverage to motivate students to pursue hydrology as a career. Universities should consider the establishment of the academic choices necessary to support multidisciplinary PhD programs in hydrological science. Present postgraduate professional courses in hydrology should be examined critically with greater emphasis on the basic sciences and a greater variety of hydrological sub-fields. Every effort should be made to ensure that the developments in hydrological science made in geoscience departments are made available to students of applied hydrology. Finally, hydrological instruction in applications areas, such as Civil Engineering, Agricultural Engineering, Environmental Engineering and Forestry, should be modified to increase their basic science content. (Mertz-PTT)
W91-04801

9D. Grants, Contracts, and Research Act Allotments

WATER RESOURCES RESEARCH GRANT PROGRAM: PROJECT DESCRIPTIONS, FISCAL YEAR 1989.
Geological Survey, Reston, VA. Water Resources Div.
M. Lew, and P. Murray.
Available from Books and Open File Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-139, 1990. 121p, 2 tab.

Descriptors: *Grants, *Research priorities, *Water resources.

Information on the 36 new projects funded by the US Geological Survey's (USGS) Water Resources Research Grant Program in fiscal year 1989 and on 27 projects completed during the year, is presented. For the new projects, the report gives the grant number, project title, performing organization, principal investigator(s), project duration, and a project description that includes: (1) identification of water-related problems and problem-solution approach; (2) contribution to problem solution; (3) objectives; and (4) approach. The 36 projects include 6 in groundwater transport and flow, 4 in the water quality treatment processes, 5 in water quality processes, 5 in biology, 9 in economics and management, and 7 in climate and hydrology. For the 27 completed projects, the report gives the grant number, project title, performing organization, principal investigator(s), starting date, date of receipt of final report, and an abstract of the final report. Each project description provides the information needed to obtain a copy of the final report. The report also contains tables showing: (1) proposals received according to area of research interest; (2) grant awards and funding according to area of research interest; (3) proposals received according to type of submitting organization; and (4) awards and funding according to type of organization. (Lantz-PTT)
W91-04858

RESEARCH PROGRAM OF THE WATER RESOURCES RESEARCH INSTITUTES, 1989-1990 (FY 1989).
National Association of Water Institute Directors, February 1990. 41p, 3 fig, 2 tab, 2 append.

Descriptors: *Research priorities, *Water resources, *Water resources institutes, Data collections, Economic aspects, Information exchange, Research facilities.

The 54 Water Resources Research Institutes (WRRI) constitute a cooperative state-federal program to promote research, training and information transfer on the nation's water resources problems. The program was authorized by the Water Resources Research Act of 1964 (P.L. 88-379) and reauthorized most recently by P.L. 98-242 in 1984. The institutes are located at the land grant university in each state, as well as four US territories. Appendix A lists the research projects supported by the Institutes with funds appropriated for the 1989 federal fiscal year. The 54 individual Institutes begin their program years during the second half of each federal fiscal year (over a period from April through September) in order to facilitate administration of the program by the USGS. The projects listed in this publication thus constitute the WRRI research program for the 1989-1990 program year, which extends nationally over an 18 month period, from April 1989 through August 1990. Short biographical descriptions of the directors of the water institutes are included in Appendix B of this report. This information shows that the academic backgrounds and professional activities of the directors reflect the breadth of disciplines involved in research on the nation's water resources. (Lantz-PTT)
W91-04860

FISCAL YEAR 1989 PROGRAM REPORT (MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE).
Mississippi State Univ., State College. Water Resources Research Inst.
T. Bond.
Available from the National Technical Information Service, Springfield, VA 22161, as PB91-104380. Price codes: A03 in paper copy, A03 in microfiche. Report No. 1571-01, July 1990. 24p. USGS Contract No. 14-08-0001-G1571-Year 2. USGS Project No. G1571-01.

Descriptors: *Information transfer, *Mississippi, *Research, *Training, *Water resources institutes, Education, Projects.

During the 1989 Program Year, the Mississippi Institute's involvement in statewide planning activities and its research program addressed major issues in Mississippi. G1571-02: The objective was to develop a physically based method to determine the fate and transport of pollutants in agricultural drainage systems. The approach considers interactions between the surface flow, sediment hydrodynamics, and chemical adsorption/desorption processes of the various constituents. G1571-03: The objective was to assess the effect of 30 yr of annual flooding on the vegetation composition and productivity of green-tree reservoirs, specifically, growth rates among selected oaks, acorn production of cherrybark oak, and soil moisture depletion. G1571-04: A 2 yr investigation has been undertaken to evaluate the toxicological consequences of humic-pesticide interactions on the fate and effects of agricultural chemicals. The specific task of the first year was to evaluate the influence of humic acid (HA) on the acute toxicity of a suite of pesticides used extensively in Mississippi and the South Atlantic-Gulf Region. G1571-05: This study is an attempt to take various techniques successfully used in topsoil and groundwater remediation and apply them to the unique conditions in the subsoil environment. The first phase of the study involved testing the effect on remediation of several combinations of inorganic nutrients applied to three types of subsoil. The results should indicate if the subsoil microbial population can be stimulated by appropriate additions of nutrients and oxygen. G1571-22: This project supported the Institute program through publication of research results, promotional and informational materials, response to requests for information and programs, and coordination of the Mississippi Water Resources Conference. G1571-32: The objectives are: (1) To assist the Department of Environmental Quality, Bureau of Land and Water Resources, and the USGS in the assessment of historical pumping records in Northeast Mississippi; (2) To provide computer aided assistance in the input of data into machine readable form for mathematical modeling of multilayers in the aquifers below Northeast Mississippi; and (3) To aid in the computations and calibrations of groundwater models for assessment of groundwater resources for permitting and management purposes in Northeast Mississippi. (USGS)
W91-04871

FISCAL YEAR 1989 PROGRAM REPORT (ALABAMA WATER RESOURCES RESEARCH INSTITUTE).
Auburn Univ., AL. Water Resources Research Inst.
J. F. Judkins.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104372. Price codes: A03 in paper copy, A03 in microfiche. Program Report G-1508-02, July 1990. 26p. USGS Contract No. 14-08-0001-G1508. USGS Project No. G-1508-02.

Descriptors: *Alabama, *Information transfer, *Research, *Training, *Water resources institutes, Education, Projects.

Alabama's Water Resources Research Institute at Auburn University provided support for four research projects. The program focuses on research and training that is responsive to identified priority problems of the State and Region. Project 02 deals with quality of life, ecological balance, and protection of endangered fish species in streams of the South Atlantic-Gulf Region. Project 03 deals with identifying physical and chemical factors that influence the transport of colloidal particles through porous media. Project 04 looks at the production and biodegradation of odorous (off-flavor) compounds synthesized by aquatic microorganisms. Systems for biodegradative removal of off-flavor or odorous compounds could permit in-pond treatment for aquaculture as well as more efficient treatment of municipal drinking waters. Project 05 looks at a microcapsulated fungal process for detoxifying organochloride paper mill wastes. The microcapsule will permit reactants to pass into and out of the microcapsule while retaining the fungus. In that way an efficient bioreactor system employing a fluidized bed can be developed to effectively detoxify hazardous organically bound chlorine compounds present in paper mill bleach plant effluents. (USGS)
W91-04872

FISCAL YEAR 1989 PROGRAM REPORT (NEW JERSEY DIVISION OF WATER RESOURCES).
Rutgers - The State Univ., New Brunswick, NJ. Div. of Water Resources.
J. G. Ehrenfeld.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104364. Price codes: A03 in paper copy, A03 in microfiche. Program Report G-1577-01, August 1990. 21p. USGS Contract No. 14-08-0001-G1577. USGS Project No. G-1577-01.

Descriptors: *Information transfer, *New Jersey, *Research, *Training, *Water resources, Education, Projects, Water resources institutes.

The 1989 New Jersey Section 104 program addressed two major topics of crucial concern to the state. Four projects were addressed to the fate and effects of toxic substances in soil and water, and one project examined the effects of acidic deposition on wetlands in the state. Studies of the fate and effects of toxic substances included laboratory and modelling studies of the mobility of heavy metals in soils, evaluation of hydrocarbons inputs and outputs in detention basins, development of techniques for promoting microbial treatment of chlorinated hydrocarbon in-situ, and assessment of the use of an invertebrate assay technique for genetic screening of hazardous substances. The study of acidic deposition was designed to determine the role of volatile reduced sulfur compounds in buffering acidified wetlands. Information transfer activities included production of a Newsletter which was widely distributed throughout the state, and hosting an annual meeting jointly with the regional chapter of the Society of Environmental Toxicologists and Chemists. (USGS)
W91-04873

FISCAL YEAR 1989 PROGRAM REPORT (NEVADA WATER RESOURCES RESEARCH INSTITUTE).
Nevada Univ. System, Reno. Water Resources Center.
J. W. Hess.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104349. Price codes: A03 in paper copy, A03 in microfiche. Desert Research Institute, Water Resources Center, Reno, Program Report G-1575-02, July 1990. 26p. USGS Contract No. 14-08-0001-G1575. USGS Project No. G-1575-02.

Descriptors: *Information transfer, *Nevada, *Research, *Training, *Water resources institutes, Education, Projects.

Nevada is one of the fastest growing states in the nation with most of the population concentrated in two urbanized areas. Providing the water supply to meet the demands of these two growing urban areas is a challenging problem. Both areas are faced with prospects of having to develop additional facilities for increasing water supplies from various sources. The purpose of one research project was to develop a methodology to determine capacity expansion of municipal water supply systems through optimal sequencing of water projects. Development and management of groundwater supplies is difficult when the aquifer is a fractured formation or is located at the end of an arid region flow system where salts accumulate and create water quality problems. The objective of one research project was to evaluate the effectiveness of recent advances in geophysical instrumentation to delineate fracture systems which would significantly affect the hydrogeology of a groundwater production area. The issue of groundwater quality and quantity is a major concern for those entities managing this limited resource. Excess waters applied to the land surface may infiltrate through the soil conducting chemical constituents to underlying aquifers. One research project has been undertaken to characterize the chemical and hydraulic nature of the shallow aquifer zone to assess the potential impact on the groundwater production zone of the Las Vegas Valley aquifer. Due to agricultural drainage outflow, salt accumulation in receiving waters has become a serious concern. One project is investigating a redesign of irrigation and drainage management systems. (USGS)
W91-04874

FISCAL YEAR 1989 PROGRAM REPORT (CALIFORNIA WATER RESOURCES RESEARCH CENTER).
California Univ., Riverside. Water Resources Center.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104331. Price codes: A03 in paper copy, A03 in microfiche. Program Report G-1550-01, 1990. 37p. USGS Contract No. 14-08-0001-G1550. USGS Project No. G-1550-01.

Descriptors: *California, *Information transfer, *Research, *Training, *Water resources institutes, Education, Projects.

This report contains a synopsis of the results of research projects sponsored under Grant No. 14-08-0001-G1550, the 1989 Water Research Institute Program (WRIP) for the University of California Water Resources Center. It also contains summaries of water problems and issues in California and the Water Resources Center's Program Goals and Priorities, Information Dissemination Activities and Cooperative Arrangements. The California WRIP package is a subset of the Center's overall research program and consists of five projects investigating the following topic areas: Mixing in Bay/Delta Flows, Dynamics of Selenium and Arsenic Oxidation in Water-Sediment Systems, Wetland Treatment of Urban Runoff, Adaptive Grid Refinement for Groundwater Contaminant Transport Simulation, Innovative Approaches to Wastewater Management Along the California-Mexico Border. (USGS)
W91-04875

FISCAL YEAR 1989 PROGRAM REPORT (GUAM WATER AND ENERGY RESEARCH INSTITUTE).
Guam Univ., Agana. Water and Energy Research Inst. of the Western Pacific.
S. Khosrowpanah.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104323. Price codes: A03 in paper copy, A03 in microfiche. Report G-1557-01, August 1990. 20p. USGS Contract No. 14-08-0001-G1557 USGS Project No. G-1557-01.

Descriptors: *Guam, *Information transfer, *Research, *Training, *Water resources institutes, Education, Projects.

An overview of the Fiscal Year 1989 research and information transfer activities accomplished by the University of Guam Water and Energy Research Institute is give. These activities were sponsored by the Water Research Institute Program of the U.S. Geological Survey and include the following completed projects: (1) A Study of Soil Erodibility Factor for Guam Watersheds (Phase II); (2) Nitrification in Guam's Soils and Sediments; (3) A Study of the Behavioral Effects of Modern Water Storage and Disposal Systems on Atoll Island Groundwater Quality in Yap State; (4) Determination of Lead and Other Selected Trace Metals in Ground and Surface Water on Guam, Mariana Islands: A Comparative Study of Analytical Methods for Quantitation at Trace Levels; and (5) Assessment of Waste Disposal on Water Resources in Micronesia and Related Water Quality Studies. (USGS)
W91-04876

FISCAL YEAR 1989 ANNUAL PROGRAM REPORT (INDIANA WATER RESOURCES RESEARCH CENTER).
Purdue Univ., Lafayette, IN. Water Resources Research Center.
J. R. Wright.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104398. Price codes: A03 in paper copy, A03 in microfiche. 25th Annual Report G1561-01, August 1990. 43p, 1 tab. USGS Contract No. 14-08-0001-G1561. USGS Project G1561-01.

Descriptors: *Indiana, *Information transfer, *Research, *Training, *Water resources institutes, Education, Projects.

The 1989 program of the Indiana Water Resources Research Center revolved around four research projects and a technology transfer program. Dr. Bernard A. Engel, Department of Agricultural Engineering at Purdue, conducted a study which focused on developing decision support software to assist in estimation of the impacts of cultural and structural management practices on agricultural runoff, sediment yield, and chemical yield on a watershed scale. A study regarding practical applications of food chain manipulation on the functioning of lake food chains, as well as ecosystem responses to declines in planktivorous fish, was conducted by Dr. William R. DeMott, Department of Biological Science at Indiana University-Purdue University at Fort Wayne. A third study was led by Dr. Ronald F. Turco, Department of Agronomy at Purdue, to understand better the fate of xenobiotic chemicals in groundwater and how the resident microbial population utilizes dissolved organic matter. Dr. Jeff R. Wright, School of Civil Engineering at Purdue, investigated using the technology of geographic information systems as a tool to enhance the ability to store, organize, and manipulate spatial water resources data. The technology transfer program involved meetings with various state, national, and private entities, as well as invited presentations to various groups. (USGS)
W91-04881

FISCAL YEAR 1989 PROGRAM REPORT (MAINE ENVIRONMENTAL STUDIES CENTER).
Maine Univ. at Orono. Environmental Studies Center.
G. K. White.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274051/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1566-02, July 1990. 25p, 2 tab, 5 append. USGS Contract No. 14-08-0001-G1566.

Descriptors: *Information transfer, *Maine, *Research, *Training, *Water resources Institutes, Education, Projects.

'Phosphorus Availability from Woodash' compared P availability from fertilizer relative to woodash as a source. Results indicate that the standard Maine soil testing extractant may not sensitively assess plant availability of P in woodash-amended soils. 'Preliminary Evaluation of Natural Controlling Factors for the Sensitivity of Maine Lakes to Phosphorus Loading' has begun assembling existing data to determine whether causal factors can be identified which allow prediction of vulnerable lakes prior to the onset of eutrophication. Preliminary results from 'The Efficiency of Constructed Wetland-Pond Systems in Reducing Sediment and Nutrient Discharges from Agricultural Watersheds' suggest that wetland-pond systems designed to reduce sediment and nutrient runoff from agricultural land are very effective. Ninety percent or more of the incoming phosphorus and suspended solid mass were retained by the system during two storm events. 'Impacts of Landspreading Wastes on Vadose Water Quality' has evaluated preliminary data from plots spread with papermill sludge. Initial results suggest reason for concern that the sludge may contribute to the deterioration of subsurface water quality. 'Organizing Information for Improved Groundwater Management' reports progress on procedures and computer algorithms to geocode wells and underground storage tanks using community tax base maps and Census Bureau TIGER files. During the second year of this project the generated spatial references will be evaluated relative to coordinates precisely determined by Global Positioning Systems. 'Information Transfer in Water Resources Management' emphasized public policy education through publications, conferences, exhibits and direct outreach programs. (White-Univ. ME, Environmental Studies Center)
W91-04887

FISCAL YEAR 1989 PROGRAM REPORT (DELAWARE WATER RESOURCES CENTER).
Delaware Univ., Newark. Water Resources Center.
R. D. Varrin.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274044/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1553-01, July 1990. 25p. USGS Project No. G1553-01.

Descriptors: *Delaware, *Information transfer, *Research, *Training, *Water resources Institutes, Education, Projects.

The fiscal year 1989 Delaware Water Research Institute Program focused on three critical water problems of the state and region: (1) contamination of groundwater; (2) water resources planning and management; and (3) sedimentation. Four projects developed information needed by water planners, managers, and users for the protection and maintenance of Delaware's groundwater supply. Included are studies of herbicide leaching, landfill leachate chemistry, runoff in groundwater recharge and landfill leaching, and electrochemical treatment of contaminated aquifers. A fifth project developed a computer program for regional groundwater modeling. The final project measured the rates of erosion, deposition, and cycling of zinc-contaminated sediments in a Delaware creek. (USGS)
W91-04888

FISCAL YEAR 1989 PROGRAM REPORT (NORTH CAROLINA WATER RESOURCES RESEARCH INSTITUTE).
North Carolina Water Resources Research Inst., Raleigh.
D. H. Morean.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-274036/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1508-01, May 1990. 27p. USGS Contract No. 14-08-0001-G1580.

Descriptors: *Information transfer, *North Carolina, *Research, *Training, *Water resources Institutes, Education, Projects.

The North Carolina Water Resources Research Institute research program for Fiscal Year 89 focused on three broad areas of concern: urban water management, surface waters, and groundwater. The Institute program also emphasized technology transfer in the form of publications, conferences, and workshops. Support from the U.S. Geological Survey through the Water Resources Institute Program was supplemented by the Urban Water Consortium, contracts with New Hanover County, the Solid Waste Section of the North Carolina Department of Human Resources, various divisions of the NC Department of Environment, Health, and Natural Resources, the US Department of Agriculture's Soil Conservation Service, and the US Environmental Protection Agency. A total of 22 research projects was funded with these combined resources. Five WRIP research projects were supported in FY 89. One examined how the dispersion of agricultural runoff over vegetative filter strips might enhance their effectiveness. A second examined sediment-water phosphate exchange in the Neuse River, NC. A third investigated the uranium disequilibrium in groundwater of northeastern North Carolina. The fourth assessed the treatability of water from Jordan Lake for drinking water purposes. The last examined the implications of disposal requirements of granular activated carbon for its use in removing radon in drinking water. The technology transfer program for the Institute focused on disseminating the results of the Institute's research program; on gathering and disseminating information on emerging water issues, law, regulations, and problems; and on transferring regulatory and technical information to facilitate changes in North Carolina's water quality. (Lambert-UNC, WRRI)
W91-04889

FISCAL YEAR 1989 PROGRAM REPORT (MISSOURI WATER RESOURCES RESEARCH CENTER).
Missouri Water Resources Research Center, Columbia.
T. E. Clevenger.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274002/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1572-01, June 1990. 19p, 1 fig, 2 tab. USGS Contract No. 14-08-0001-G1572.

Descriptors: *Information transfer, *Missouri, *Research, *Training, *Water resources Institutes, Education, Projects.

The Missouri Water Resources Research Center's goals are: (1) to establish research programs that will assist in the study of Missouri's water problems; (2) to provide an educational program that offers graduate students with an interest in water or related fields, the opportunity to continue their education in these areas; and (3) to be actively dedicated to the dissemination of information through all aspects of the media in reaching the researcher, users and citizens of Missouri with informative water related news and research ideas on the future of Missouri's water. Areas of research covered under this grant include: (1) The Effect of River-Aquifer Interactions on Contaminant Transport Processes in the Missouri River Alluvial Aquifer; (2) Development of New Methodology for the Assessment of Water Treatment Plant Performance with Respect to the Removal of Cyst-Size Particles; (3) Transport of Pesticides Through Profiles of Swelling-Shrinking Soils; and (4) Characterization of the Algal Component of Groundwater Microflora and Organic Compounds Supporting Their Growth. (Clevenger-Univ. Missouri-Columbia)
W91-04890

FISCAL YEAR 1989 PROGRAM REPORT (SOUTH CAROLINA WATER RESOURCES RESEARCH CENTER).
Clemson Univ., SC. Water Resources Research Inst.
P. B. Zielinski, and E. J. Hayter.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274028/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1588-01, June 1990. 43p, 3 fig, 4 tab, 16 ref. USGS Contract No. 14-08-0001-G1588-01.

Descriptors: *Information transfer, *Research, *South Carolina, *Training, *Water resources Institutes, Education, Projects.

This report describes the accomplishments of the South Carolina Water Resources Research Institute during the 1989 program year. (1) The fate of spills of volatile liquids in downward transport through the ground versus volatilization is being studied for a second year by Thomas Overcamp of the Department of Environmental Systems Engineering, Clemson University; (2) The second year of a project to predict the fate of PCB's in Lake Hartwell, South Carolina, and the effects of proposed remedial actions was conducted by Alan Elzerman and Kevin Farley, both of the Department of Environmental Systems Engineering, Clemson University; (3) The complex nature of multiphase transport behavior of flow of hydrocarbons in porous media was studied for a second year by Kevin J. Farley; (4) The first year of a study to evaluate groundwater as a source of elevated levels of indoor radon in South Carolina was conducted by Robert Fjeld of the Department of Environmental Systems Engineering, Clemson University; (5) The first year of a project to predict groundwater recharge in the piedmont of South Carolina was conducted by James Ligon of the Department of Agricultural Engineering, Clemson University; and (6) The first year of a study of the effect of Trichorfon on the immune response of catfish was conducted by Steven Hayasaka and Thomas Schwedler. (Hayter-Clemson U., WRRI)
W91-04891

FISCAL YEAR 1989 PROGRAM REPORT (RHODE ISLAND WATER RESOURCES CENTER).
Rhode Island Univ., Kingston. Water Resources Center.
C. P. C. Poon.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274010/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1612-02, July 1990. 26p. USGS Contract No. 14-08-0001-G1612.

Descriptors: *Information transfer, *Research, *Rhode Island, *Training, *Water resources Institutes, Education, Projects.

The State of Rhode Island is active in water resources planning, development and management activities which include legislation, upgrading of wastewater treatment facilities, upgrading and implementing pretreatment programs, protecting watersheds and aquifers throughout the State. Current and anticipated state water problems are the lack of the understanding of the potential of pricing as a means of demand management, high rate of land development in the state leading to deteriorating surface and groundwater quality, impact of nitrate pollution on turf farms from organic composts, and heavy metal as well as cyanide contamination from industrial wastewater discharges. These problems were addressed in projects in the FY-1989 program including: (1) Water Pricing Structure in Water Policy; (2) Lakes/Ponds Water Quality; (3) Scituate Reservoir Water Quality Assessment; (4) The Use of Organic Composts in Turf Farms and the Impact on Groundwater Quality; and (5) Treatment of Heavy Metals and Cyanide from Industrial Wastewater. This Center works closely with the R.I. Department of Environmental Management, USEPA Region 1 Office, other New England Water Resources Centers, R.I. cities and towns, citizen groups, Providence Water Supply Board in program planning, research coordination and program implementation. (Poon-RI Univ., WRC)
W91-04892

FISCAL YEAR 1989 PROGRAM REPORT (MICHIGAN INSTITUTE OF WATER RESEARCH).
Michigan State Univ., East Lansing. Inst. of Water Research.
J. F. Bartholic.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-273996/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1569-01, March 1990. 40p. USGS Contract No. 14-08-0001-G1569. USGS Project No. 89-G1569-01.

Descriptors: *Information transfer, *Michigan, *Research, *Training, *Water resources Institutes, Education, Projects.

The major thrust of the Michigan Institute of Water Research during the 1989 program year continued to involve activities related to its research programs, statewide water resources planning activities, use of geographic information systems and the technology transfer program. Water management planning along with surface and groundwater contamination problems are still the top priority issues in the state at the present time. Research projects funded by the Institute of Water Research to address these problems and issues included: (1) surface/subsurface flow equations interactions to identify sources of groundwater contamination; (2) the hydrogeological and hydrogeochemical characterization and implication for consumptive use of a glacial drift aquifer system in southwest Michigan; (3) potential nitrogen contamination of groundwater as affected by soil, water, and land use relationships; (4) water resource management system for expanded irrigation in the Saginaw Valley; and (5) the development and implementation of the Institute of Water Research technology transfer program through publication and dissemination of research results, distribution of a water related newsletter and information materials, responses to requests for information, coordination of conferences and publication of conference proceedings, and the development of educational audio-visual programs (22). (USGS)
W91-04893

FISCAL YEAR 1989 PROGRAM REPORT (MARYLAND WATER RESOURCES RESEARCH CENTER).
Maryland Univ., College Park. Water Resources Research Center.
G. E. Gordon.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-273988/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1567-02, July 1990. 24p, 3 fig, 7 ref. USGS Contract No. 14-08-0001-G1567. USGS Project No. G1567-02.

Descriptors: *Information transfer, *Maryland, *Research, *Training, *Water resources Institutes, Education, Projects.

In response to the priorities and goals for 1989 of the Maryland Water Resources Research Center, four research projects and two information transfer projects were supported. The projects dealt with nitrogen fluxes and utilization in a subestuary of Chesapeake Bay, the use of molybdenum in sediments to determine the history of anoxia in Chesapeake Bay, toxic metal biomagnification in surface films in the Bay, and the recovery of submerged aquatic vegetation in the Bay. Submerged aquatic vegetation in some areas of the Bay has recovered substantially in recent years, but possibly because 1985-1988 were drought years. In field mesocosm experiments, increased loading of N and P both resulted in significant increases of total biomass of epiphytic algae. However, field studies showed that submerged aquatic vegetation growth was reduced in 1989 because light penetration was already poor by early July due to much greater water flow. In the dry years of 1987-88, nitrogen fluxes were high in Spring in the Choptank River. In the dry years of 1987-88, nitrogen fluxes were high in Spring 1989, fluxes started higher and

remained higher throughout the season. Cores from one site on the western shore of Chesapeake Bay and one site on the Eastern Shore yield preliminary indications that the sediments at those locations have been fairly anoxic since about 1750. Tributyl tin (TBT) and heavy metals are concentrated in most, but not all, biofilms studied. TBT is particularly toxic to oyster larvae. Very low sublethal levels are rapidly concentrated to lethal levels in biofilms. (USGS)
W91-04894

FISCAL YEAR 1989 PROGRAM REPORT (KANSAS WATER RESOURCES RESEARCH INSTITUTE).
Kansas Water Resources Research Inst., Manhattan.
H. S. Jacobs.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-273699/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1563-01, May 1990. 19p. USGS Contract No. 14-08-0001-G1563.

Descriptors: *Information transfer, *Kansas, *Research, *Training, *Water resources Institutes, Education, Projects.

The FY 1989 KWRRI research program addressed two priority research concerns in Kansas and includes a total of five projects--four in water quality and one in stream-aquifer interaction. Three projects in water quality were concerned with the impact of constituents in water and included: Leaching of Atrazine and Nitrate through Soil into Groundwater; Microbial Contamination of Surface and Groundwaters Adjacent to Agricultural Enterprises in Kansas; and Denitrification of the Vadose Zone: A Mechanism for Nitrate Removal. A fourth research project in water quality was directed at hydrogeologic characterization of hazardous waste sites. This research focused on predictions of subsurface movement of contaminants in water flow. The study, Stream Floodwave Propagation Through the Great Bend Alluvial Aquifer, demonstrated that water level fluctuations in wells located along paleochannels is correlated with streamflow levels and is a significant recharge mechanisms. A total of 6 undergraduate, 9 Masters, and 3 Ph. D. degree candidates participated in the 1989 program. (Jacobs-KS St Univ, KWWRI)
W91-04895

FISCAL YEAR 1989 PROGRAM REPORT (VERMONT WATER RESOURCES RESEARCH CENTER).
Vermont Water Resources Research Center, Burlington.
A. W. McIntosh.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-273681/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1594-01, July 1990. 25p. USGS Contract No. 14-08-0001-G1594.

Descriptors: *Information transfer, *Research, *Training, *Vermont, *Water resources Institutes, Education, Projects.

Research scientists participating in the FY 89 Vermont Water Resources Research Center program investigated various issues related to the quality of Vermont's surface and groundwaters. Two projects focused on stream quality, with one investigating the interactions between phosphorus and stream algal communities and the other assessing the effects of iron bacteria on the ecology of a small stream. A third project identified the effects of drawdown, a method for controlling aquatic plant growth, on a Vermont lake. The toxicity of aluminum to plant roots was considered in a fourth study, while the final research project assessed the microbial quality of Vermont's groundwater. Efforts at information transfer included the publication of a newsletter, the organization of a two-day symposium on Lake Champlain, the initiation of a research consortium designed to focus on Lake Champlain issues, and the organization of a Lake Champlain Summer Institute designed to offer courses to a wide range of user groups. (McIntosh-Univ. VT)
W91-04896

FISCAL YEAR 1989 PROGRAM REPORT (NEW YORK STATE WATER RESOURCES INSTITUTE).
New York State Water Resources Research Inst., Ithaca.
K. S. Porter.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-273673/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1579-02, July 1990. 16p. USGS Contract No. 14-08-0001-G1579.

Descriptors: *Information transfer, *New York, *Research, *Training, *Water resources Institutes, Education, Projects.

Like many other States, New York continues to struggle with problems of groundwater contamination, particularly from nonpoint contaminant sources. An increasing array of human activities now falls under legal rules designed to protect groundwater quality, such as petroleum and hazardous material storage regulations. However, since groundwater is affected by most human activities on the land, many possibly-significant contaminant sources remain uncontrolled and groundwater protection remains uncertain. The federally-funded portion of New York's FY89 program consisted primarily of four projects which considered three groundwater contaminant sources. One project concentrated on impacts of septic systems on rural groundwater quality, emphasizing groundwater tapped by private wells. Two concentrated on the impact of pesticides on groundwater, one on site-scale assessment methods for turfgrass systems and the other on regional-scale assessments utilizing a geographic information system. The fourth project focused on the mechanical performance of geosynthetic materials used increasingly for in-ground containment of hazardous materials. (Pacenka-Cornell Univ. Ithaca, NY)
W91-04897

FISCAL YEAR 1989 PROGRAM REPORT (KENTUCKY WATER RESOURCES RESEARCH INSTITUTE).
Kentucky Water Resources Research Inst., Lexington.
B. J. Barfield, and R. R. Huffsey.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104315/AS. Price codes: A03 in paper copy, A03 in microfiche. Program Report G1564-01, July 1990. 21p, 21 ref. USGS Contract No. 14-08-0001-G1564. USGS Project No. G1564-01.

Descriptors: *Information transfer, *Kentucky, *Research, *Training, *Water resources Institutes, Education, Projects.

The Annual Report of the Kentucky Water Resources Research Institute for Fiscal Year 1989, describes the problems and issues facing the Commonwealth of Kentucky. The program goals and priorities describe the areas of water resources research the Institute addressed in 1989. A synopsis of each of the four research projects funded is included. The four projects are as follows: Project 02, 'Metal Speciation and Immobilization Reactions Affecting the True Efficiency of Artificial Wetlands to Treat Acid Mine Drainage', is a study of the ability of various organic substances found in wetland areas to reduce acidity and levels of aluminum and iron. Project 03, 'Effects of Aromatic Concentrations on Methane Fermentation', evaluated the kinetics of biodegradation and inhibition of aromatic compounds under anaerobic conditions. Project 04, 'Modeling Mass Transport in Aquifers: The Distributed Source Problem', is developing a new methodology which will allow groundwater modeling to be represented mathematically and solve the distributed source problem. Project 05, 'Interrelationships Between Carbonate Aquifer Shallow Conduit Flow and Pollution From Surface Activities',is documenting, for the first time, surface-groundwater interactions in karst terrains. The Institute's technology transfer activities for 1989 are included along with the cooperative arrangements that exist between the Institute and participating universities. Training accomplishments for FY 1989 research projects are given in terms of category and academic level. (Huffsey-Univ. KY, WRRI)
W91-04898

FISCAL YEAR 1989 PROGRAM REPORT (VIRGINIA WATER RESOURCES RESEARCH CENTER).
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
W. R. Walker.
Available from National Technical Information Service, Springfield, VA 22161 as PB91-104356/AS. Price codes: A04 in paper copy, A04 in microfiche. Program Report G1596-01, August 1990. 47p, 3 tab, 3 append. USGS Contract No. 14-08-0001-G1596. USGS Project No. G1596-01.

Descriptors: *Information transfer, *Research, *Training, *Virginia, *Water resources Institutes, Education, Projects.

The Virginia Water Resources Research Center's 1987-1992 Five-Year Plan has focused on four major water resource issues confronting Virginia: (1) water resources planning; (2) land use effects on water resources; (3) land application of sewage sludge; and (4) water-related health concerns. During the 1989 federal fiscal year, the Center sponsored eight research projects and 18 students (11 graduate and 7 undergraduate). The research projects emphasized three of the major water resources issues described in the five-year plan: a comprehensive assessment of the effectiveness and impacts of agricultural BMPs applicable to Virginia; computer modeling of the effects of agricultural practices on groundwater and surface water, including the Chesapeake Bay; the economic impacts and managerial implications for Virginia's water supply industry of the 1986 amendments to the Safe Drinking Water Act; the potential of natural soil microbes to degrade pollutants in the soil; enhancing denitrification in on-site wastewater disposal systems; determining the kinetics of herbicide biodegradation in wetland soils; assessing the in-stream flows necessary to maintain Virginia's aquatic resources; and recognizing the value of Virginia's nontidal wetlands. During the past two years, two conferences have been sponsored or cosponsored by the Center-the '1990 Virginia Water Resources Forum' (with the Virginia Lakes Association), 'Ground Water in the Piedmont of the Eastern United States' (with eight cosponsors)-and preparations for the third annual national pesticide conference 'Pesticides in the Next Decade: The Challenges Ahead' (with 17 cosponsors) are underway. Proceedings for the 1989 conference 'Pesticides in Terrestrial and Aquatic Environments' and two research bulletins were published. More than 24,000 publications were distributed by the Center during the year. In addition to the monthly newsletter Water News sent to 10,000 individuals and the bulletins and proceedings, the Center staff completed publications on solid waste, recycling, and the Water Institute's and U.S. Geological Survey's program on groundwater research. (Weigmann-VI Tech)
W91-04899

FISCAL YEAR 1989 PROGRAM REPORT (WEST VIRGINIA WATER RESOURCES RESEARCH INSTITUTE).
West Virginia Univ., Morgantown. Water Research Inst.
C. R. Jenkins.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-274150/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1598-01, June 1990. 38p. USGS Contract No. 14-08-0001-G1598.

Descriptors: *Information transfer, *Research, *Training, *Water resources Institutes, *West Virginia, Education, Projects.

The West Virginia Water Resources Research Institute Program was planned in collaboration with regional interests. Eight research projects supported 35 students. Gray is developing a computer

aided procedure for designing emergency spillways of dams located in confining terrain. Bissonette investigated techniques to enhance detection of coliforms in untreated groundwater supplies. Various media and environmental conditions were applied to microorganisms captured on .45 micrometer and .22 micrometer filters. Singh and Keefer monitored groundwater and surface water from mineland reclaimed using fly ash. Heavy metals and other cations were measured and compared with water from unvegetated mine spoils. Hunter and Waterman conducted a public opinion survey of residents of West Virginia and Ohio to determine level of knowledge and level of concern for water problems. Major differences were detected. Wimmer developed a new method for pesticide analysis using a CG Mass Spectrophotometer. The project has led to at least two new research projects. Bowders and Sencindiver found that phosphatic clays applied to mine refuse reduces acid mine drainage problems. Seepage can be reduced 97%, and heavy metal and acidity concentrations to 95% to 99%. Skousen organized the annual American Society of Surface Mining and Reclamation Conference in Charleston, West Virginia. Over 700 attendees participated in 125 presentations. The Conference Proceedings were published. Eli and Dean are attempting to develop a more cost effective method of predicting streamflow response of first order and larger streams. The goal is to provide low flow frequency data and the expected flood response of a given ungaged watershed within the context of a geographic information system. (Jenkins-WV Univ, WRI)
W91-04900

10. SCIENTIFIC AND TECHNICAL INFORMATION

10A. Acquisition And Processing

COORDINATION OF FEDERAL WATER-USE DATA COLLECTION AND DISSEMINATION.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 6D.
W91-04163

WATER-USE DATA AND INFORMATION TRANSFER.
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 6D.
W91-04175

10C. Secondary Publication And Distribution

BETTER WATER QUALITY INDEXING SYSTEM FOR RIVERS AND STREAMS.
Department of Scientific and Industrial Research, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5G.
W91-04078

SOIL SALINITY: IRRIGATION PRACTICES AND EFFECTS ON CROPS AND GROUND WATER (JAN 77--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 3C.
W91-04649

HEAVY METALS IN DRINKING WATER: STANDARDS, SOURCES, AND EFFECTS (JAN 70--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W91-04650

WATER QUALITY STANDARDS (JAN 70--MAY 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5F.
W91-04651

STORAGE TANK MONITORING (EXCLUDES RADIOACTIVE WASTE STORAGE TANKS) (JAN 76--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5A.
W91-04652

WASTEWATER TREATMENT: DYE AND PIGMENT INDUSTRY (JAN 77--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W91-04653

CONTINUOUS AND PASSIVE ENVIRONMENTAL RADON MONITORING: MEASURING METHODS AND HEALTH EFFECTS (JAN 75--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5A.
W91-04654

HUMIC ACIDS: CHARACTERIZATION AND INTERACTIONS IN NATURAL AND WASTEWATER SYSTEMS (JAN 78--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 2H.
W91-04655

ACTIVATED SLUDGE PROCESS: WASTE TREATMENT (JAN 85--JUL 89).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W91-04656

BIODEGRADATION OF PESTICIDES (DEC 85--MAY 90).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5B.
W91-04657

BIOFILMS AND BIOFILM REACTORS (APR 79--MAR 90).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W91-04658

BIODEGRADATION OF PESTICIDES AND HERBICIDES (MAR 78--MAR 90).
National Technical Information Service, Springfield, VA.
For primary bibliographic entry see Field 5D.
W91-04659

10D. Specialized Information Center Services

AGGREGATED WATER-USE DATA SYSTEM.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04181

DBASE III PLUS, YET ANOTHER DATA BASE FOR WATER-USE DATA.
Idaho Dept. of Water Resources, Boise.
For primary bibliographic entry see Field 6D.
W91-04182

U.S. GEOLOGICAL SURVEY'S NEW SITE-SPECIFIC WATER-USE DATA SYSTEM (NEWSWUDS).
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04183

GREAT LAKES REGIONAL WATER-USE DATA BASE--A WATER-RESOURCES MANAGEMENT TOOL.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 6D.
W91-04204

10F. Preparation Of Reviews

PERSISTENT POLLUTANTS IN FISH-EATING SEA BIRDS--BIOACCUMULATION, METABOLISM, AND EFFECTS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
For primary bibliographic entry see Field 5B.
W91-04011

SUBJECT INDEX

ABALONE
Toxicity of an Oil Dispersant to the Early Life Stages of Four California Marine Species.
W91-04629 5C

ABLATION
Ablation of Avalanched and Undisturbed Snow, Himalaya Mountains, Pakistan.
W91-04129 2C

ABRASION
Operational Problems and Development of a New Runner for Silty Water.
W91-04428 8C

ACARICIDES
Behavior of Diazinon in a Perch Species.
W91-04256 5B

ACCOUNTING
Natural Resource Accounting Systems and Environmental Policy Modeling.
W91-04563 6B

ACETYLCHOLINESTERASE
Effect of Fluoride on Acetylcholinesterase Activity and Oxygen Consumption in a Freshwater Field Crab, Barytelphusa guerini.
W91-04023 5C

Use of Acetylcholinesterase Activity to Detect Sublethal Toxicity in Stream Invertebrates Exposed to Low Concentrations of Organophosphate Insecticides.
W91-04735 5A

ACID LAKES
Iron Redox Effects on Photosynthesis Phosphorus Release from Dissolved Humic Materials.
W91-04000 2H

Shortcomings of Gran Titration Procedures for Determination of Alkalinity and Weak Acids in Humic Water.
W91-04087 7B

Forms of Metals in a Sediment Core of a Severely Acidified Northern Black Forest Lake.
W91-04257 5A

ACID MINE DRAINAGE
Pore-Water Geochemistry and the Mineralogy of the Vadose Zone of Sulfide Tailings, Waite Amulet, Quebec, Canada.
W91-04271 5B

Passive Treatment Technology Cleans Up Colorado Mining Waste.
W91-04813 5G

Chemistry of Iron, Aluminium, and Dissolved Organic Material in Three Acidic, Metal-Enriched, Mountain Streams, as Controlled by Watershed and In-Stream Processes.
W91-04936 2E

ACID RAIN
Dissolution of Feldspars in the Presence of Natural, Organic Solutes.
W91-03986 2J

Dimethyl Sulfide Production from Dimethylsulfoniopropionate in Coastal Seawater Samples and Bacterial Cultures.
W91-04064 2K

Shortcomings of Gran Titration Procedures for Determination of Alkalinity and Weak Acids in Humic Water.
W91-04087 7B

Dew Chemistry and Acid Deposition in Glendora, California, During the 1986 Carbonaceous Species Methods Comparison Study.
W91-04138 5B

Analysis of Atmospheric Precipitation by Reversed-Phase Ion-Pair Chromatography.
W91-04265 5A

Smog-Fog-Smog Cycle and Acid Deposition.
W91-04301 2K

One-Dimensional Numerical Model to Simulate Formation and Balance of Sulfate During Radiation Fog Events.
W91-04302 2K

Subcellular Localization of Acid-Rain Transported Aluminum in Gills and Kidneys of Trout from Streams of the Vosges: Preliminary Results, (Localisation Subcellulaire de l'aluminium Vehicule par les Pluies Acides dans les Reins et Branchies de Truite des Vosges. Donnees Preliminaires).
W91-04364 5B

Influence of Water Chemistry on Size Structure of Zooplankton Assemblages.
W91-04442 2H

Effect of Simulated Acid Rain on Reproductive Attributes of Red Spruce (Picea rubens Sarg).
W91-04449 5C

Hydrogeochemical Data from an Acidic Deposition Study at McDonalds Branch Basin in the New Jersey Pinelands, 1983-86.
W91-04472 5B

Effect of Simulated Acidic Fog on Carbohydrate Leaching, CO2 Assimilation and Development of Damage Symptoms in Young Spruce Trees (Picea abies L. Karst).
W91-04560 5C

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Acidity as a Factor in Leaching of Copper, Chromium and Arsenic from CCA Treated Dimension Lumber.
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Effects of Acidic Precipitation on the Water Quality of Streams in the Laurel Hill Area, Somerset County, Pennsylvania, 1983-86.
W91-04636 5C

Water Resources Data for Wisconsin, Water Year 1989.
W91-04869 7C

Hydrologic Flow Path Definition and Partitioning of Spring Meltwater.
W91-04925 5B

Chemical Weathering in the Loch Vale Watershed, Rocky Mountain National Park, Colorado.
W91-04926 2J

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Groundwater and Wetland Contributions to Stream Acidification: An Isotopic Analysis.
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Dissolution of Feldspars in the Presence of Natural, Organic Solutes.
W91-03986 2J

Granite Weathering and the Sensitivity of Alpine Lakes to Acid Deposition.
W91-03998 2H

Forms of Metals in a Sediment Core of a Severely Acidified Northern Black Forest Lake.
W91-04257 5A

Subcellular Localization of Acid-Rain Transported Aluminum in Gills and Kidneys of Trout from Streams of the Vosges: Preliminary Results, (Localisation Subcellulaire de l'aluminium Vehicule par les Pluies Acides dans les Reins et Branchies de Truite des Vosges. Donnees Preliminaires).
W91-04364 5B

Response of Growth, Photosynthesis, and Mineral Nutrition of Red Spruce Seedlings to Ozone and Acidic Cloud Deposition.
W91-04450 5C

Response of Yellow-Poplar (Liriodendron tulipifera L.) Seedlings to Simulated Acid Rain and Ozone--2. Effect on Throughfall Chemistry and Nutrients in the Leaves.
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Foliar Retention of 15-N-Nitrate and 15-N-Ammonium by Red Maple (Acer rubrum) and White Oak (Quercus alba) Leaves from Simulated Rain.
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Do Organic and Anthropogenic Acidity Have Similar Effects on Aquatic Fauna.
W91-04528 5C

Submersed Macrophyte Growth at Low pH: I. CO2 Enrichment Effects with Fertile Sediment.
W91-04529 5C

Effect of Simulated Acidic Fog on Carbohydrate Leaching, CO2 Assimilation and Development of Damage Symptoms in Young Spruce Trees (Picea abies L. Karst).
W91-04560 5C

Design and Performance of an Acidic Precipitation Delivery System for Field Investigation with Plants.
W91-04568 5C

Plasma Vitellogenin Levels in Pre-spawning Rainbow Trout, Oncorhynchus mykiss, during Acid Exposure.
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Acidity as a Factor in Leaching of Copper, Chromium and Arsenic from CCA Treated Dimension Lumber.
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Effects of Acidic Precipitation on the Water Quality of Streams in the Laurel Hill Area, Somerset County, Pennsylvania, 1983-86.
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Effects of Acid Precipitation on Reproduction in Birds.
W91-04774 5C

Structure of Epilithon in Some Acidic and Circumneutral Streams in South Westland, New Zealand.
W91-04812 2H

Dissolved Organic Carbon Cycling in Forested Watersheds: A Carbon Isotope Approach.
W91-04924 2K

Hydrologic Flow Path Definition and Partitioning of Spring Meltwater.
W91-04925 5B

Influence of Temperature and Mineral Surface Characteristics on Feldspar Weathering Rates in Natural and Artificial Systems: A First Approximation.
W91-04932 5C

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Do Organic and Anthropogenic Acidity Have Similar Effects on Aquatic Fauna.
W91-04528 5C

ACID STREAMS

Structure of Epilithon in Some Acidic and Circumneutral Streams in South Westland, New Zealand.
W91-04812 2H

Chemistry of Iron, Aluminium, and Dissolved Organic Material in Three Acidic, Metal-Enriched, Mountain Streams, as Controlled by Watershed and In-Stream Processes.
W91-04936 2E

ACIDIC WATER

Shortcomings of Gran Titration Procedures for Determination of Alkalinity and Weak Acids in Humic Water.
W91-04087 7B

Dew Chemistry and Acid Deposition in Glendora, California, During the 1986 Carbonaceous Species Methods Comparison Study.
W91-04138 5B

Effects of Acid Wastes from Titanium Dioxide Production on Biomass and Species Richness of Benthic Algae.
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W91-04932 5C

Chemistry of Iron, Aluminium, and Dissolved Organic Material in Three Acidic, Metal-Enriched, Mountain Streams, as Controlled by Watershed and In-Stream Processes.
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W91-04075 5D

Determination of Mono- and Non-Ortho Coplanar PCBs in Fish.
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Activated Sludge Process: Waste Treatment (Jan 85--Jul 89).
W91-04656 5D

ACTIVATED SLUDGE PROCESS

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* U.S. G.P.O.:1991-281-553:20012

Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

6 WATER RESOURCES PLANNING

7 RESOURCES DATA

8 ENGINEERING WORKS

9 MANPOWER, GRANTS, AND FACILITIES

10 SCIENTIFIC AND TECHNICAL INFORMATION

INDEXES

SUBJECT INDEX

AUTHOR INDEX

ORGANIZATIONAL INDEX

ACCESSSION NUMBER INDEX

1991 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports

Standard Prices		*Exception Prices*	
A01	$8.00	E01	$10.00
A02	11.00	E02	12.00
A03	15.00	E03	14.00
A04–A05	17.00	E04	16.50
A06–A09	23.00	E05	18.50
A10–A13	31.00	E06	21.50
A14–A17	39.00	E07	24.00
A18–A21	45.00	E08	27.00
A22–A25	53.00	E09	29.50
A99	*	E10	32.50
		E11	35.00
"N" Codes		E12	38.50
		E13	41.00
N01	$60.00	E14	45.00
N02	59.00	E15	48.50
N03	20.00	E16	53.00
		E17	57.50
		E18	62.00
		E19	69.00
		E20	80.00
		E99	*

Computer Products

Diskettes		*Magnetic Tapes*	
D01	$50	T01	$165
D02	80	T02	220
D03	130	T03	340
D04	180	T04	450
D05	230	T05	560
D06	280	T06	670
D07	330	T07	780
D08	380	T08	890
D09	430	T09	1,000
D10	480	T10	1,110
D11	530	T11	1,220
D12	580	T12	1,330
D13	630	T13	1,440
D14	680	T14	1,550
D15	730	T15	1,660
D16	780	T16	1,770
D17	830	T17	1,880
D18	880	T18	1,990
D19	930	T19	2,100
D99	*	T99	*

* Contact NTIS for price

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